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By Order of The Minnesota Legislature of 1895.

THE
Forest Tree Planter's
Manual.



ELEVENTH EDITION.

"Forests are the Lungs of Agriculture."

—BY—

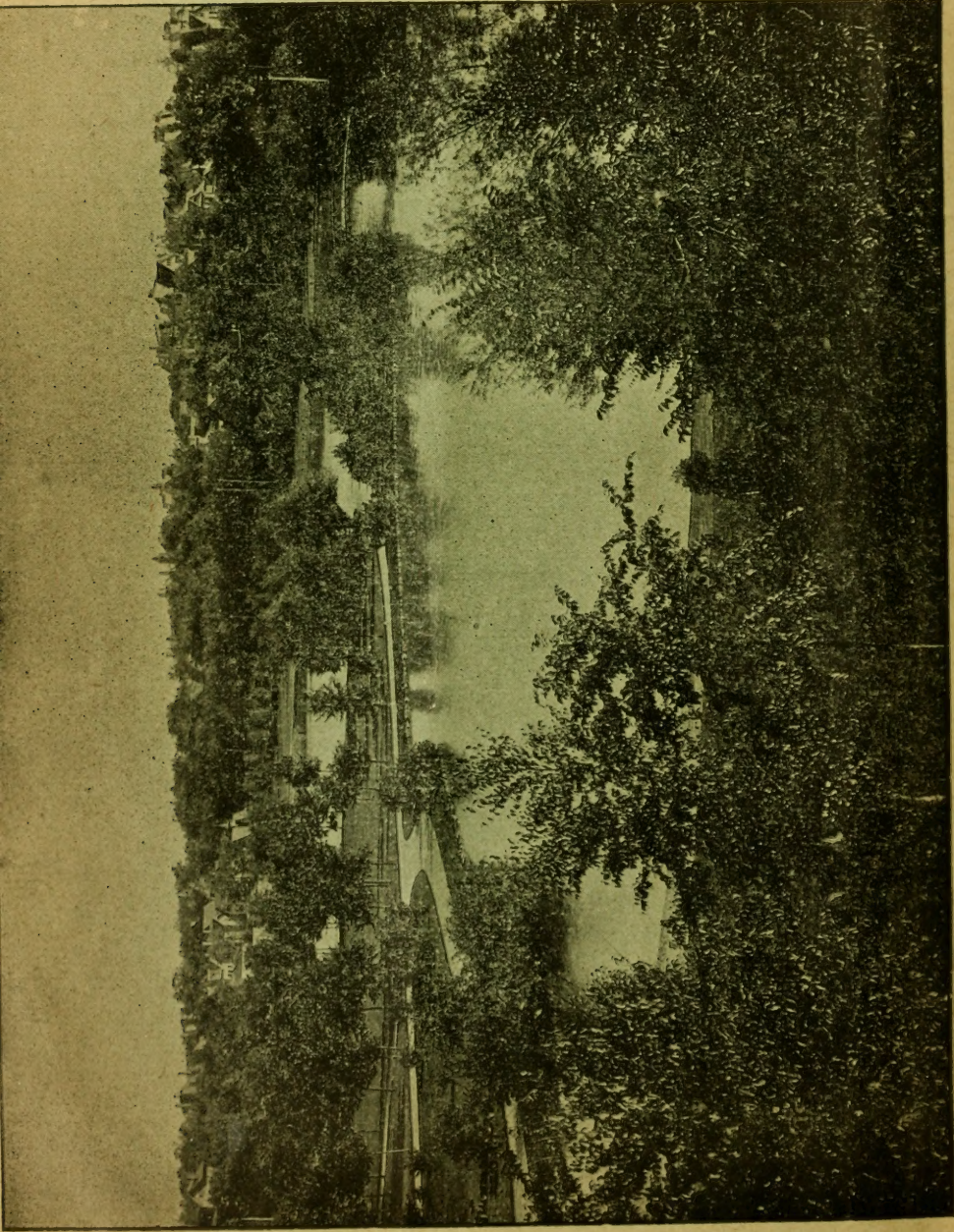
J. O. BARRETT.

Secretary of the State Forestry Association

MINNEAPOLIS, MINN.

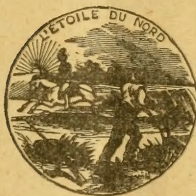
Minneapolis, Minn.
THE PROGRESSIVE AGE.
1895.

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Printers,
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1895.

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J. O. BARRETT,	Secretary.
R. S. MACINTOSH,	Treasurer

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Wyman Elliot,	H. B. Ayers,	A. M. Brand.
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THE STATE FORESTRY ASSOCIATION OF MINNESOTA.

—ORGANIZED, 1876.—

It labors for the dissemination of knowledge pertaining to the planting and culture of trees, water economy and climatic healthfulness. It also distributes trial seeds and seedlings to our citizens.

Its literature may be had by sending sufficient stamps to pay the postage. The Forest Tree Planter's Manual is an invaluable treatise. It should be the Pocket Companion of every person who is interested in forestry and its kindred reforms. Postage four cents.

All letters for information on the subject of forestry, cheerfully and promptly answered. Address, with stamp enclosed for reply,

BY TRANSFER J. O. BARRETT,
Brown's Valley, Minn.
AUG 22 1910

Sept. 19, 1910
M.C.B.

LETTER TO THE GOVERNOR.

Hon. D. M. Clough, Governor of Minnesota:

Dear Sir: In accord with the act appropriating support for the State Forestry Association, I herewith summarize the work of 1895.

The 10,000 copies of the 10th edition of the Tree Planter's Manual, issued in 1894, mainly sent out this year, has been widely distributed over the state. It has been largely called for in other states, Canada, and Europe.

Early last fall the association issued and mailed 10,000 copies of another pamphlet, entitled "Forestry in our Schools," which has been warmly received by the educators and press of Minnesota.

Last spring the association freely distributed a goodly quantity of young evergreens and in the fall over 40,000 hazelnuts to our citizens for trial on the prairie, recommended for brushwood protection to our planted trees and a valuable nut for the market and home.

10,000 copies of this 11th edition of the Manual has just been issued. The year 1895 demarks three forward steps in forestry—tree planting to conserve moisture for agriculture—better care of our state forest lands—protection of our forests from fires by a forest fire warden system.

EXPENSE ACCOUNT OF FISCAL YEAR, 1894

By balance, ...	649.47
" Appropriation	1,500.00
	\$2149.47

Aug. 4, 1894, to Jan. 26, 1895, McClellan Co., stock for 10th edition of Manual and envelopes	138.27
Sept. 17, Crown Pub. Co. publishing 10,000 copies Manual	275.00
Oct. 3, Mpls. Book Pub. Co. binding 500 cops. in cloth . .	60.75
Aug. 4, '94 to July 22, '95, postage, express, railroad, etc.	231.65
Nov. 13 1894 to Mar. 28, 1895, 725 pckgs. acorns for trial	35.77
Jan. 29, 1895, to Mar. 28, expenses of Executive Committee	50.66
Aug. 14 '94 to July 31, '95, W. R. Dobbyn, ptg. for'y literature	366.25
Aug. 4, 1894 to July 22, 1895, J. O. Barrett, work preparing and distributing forestry literature, plants and seeds,	789.00

Total to July 31, 1895, ...	\$2,047.35
To balance	102.12

\$2,149.47 \$2,149.47

J. O. BARRETT,
Secretary.

The tree of the field is man's life.—Moses.

How foolishly men destroy the forest cover without any regard for consequences, for thereby they rob themselves of wood and water!—Humboldt.

So profound is our ignorance and so high our presumption, that we marvel when we hear of the extinction of an organic being; and as we do not see the cause, we invoke cataclysms to desolate the world, or invent laws on the duration of the forms of life.—Charles Darwin.

The complete denudation of valley and mountain and plain on this continent causes infertility, long drouths, disastrous floods, and at last desolation and death of our race. The fate of the Orient will be repeated in the Occident unless we conserve and plant forests.—J. Sterling Morton, originator of Arbor Day.

The earth is fast becoming an unfit home for its noblest inhabitant, and another era of equal human crime and human improvidence, and of like duration with that through which traces of that crime and that improvidence extend, would reduce it to such a condition of impoverished productiveness, of shattered surface, of climatic excess, as to threaten the depravation, barbarism, and, perhaps, even the extinction of the species.—Geo. P. Marsh.

Joy for the sturdy trees!
Fanned by each fragrant breeze,
Lovely they stand!
The song birds o'er them thrill,
They shade each tinkling rill,
They crown each swelling hill,
Lowly or grand.
Plant them by stream or way,
Plant where the children play
And toilers rest;
In every verdant vale,
On every sunny swale,
Whether to grow or fail—
God knoweth best.

F. S. Smith, author of *America*.

PLANT LIFE.

ITS ORGANS AND FUNCTIONS.

A summary of plant life will help us in correct methods of treating it for its beneficent uses. Its original protoplasm does all the work, shaping the cells, developing the color, the beauty and other qualities of value. The stem is its body, holding all the organs in proper relation to soil, air, water, light, electricity; at the very beginning it produces roots; rising out of the soil, it bears sub stems or limbs, leaves and flowers, and transfers food from part to part, acting ever as a store house. The leaves are its breathing apparatus. The flowers are its reproductive organs. The fruit is the offspring of the plant, its seed, its prophecy of repetition in identity.

ROOT SYSTEM.

Roots consist of an elongated central axis, having walled cells and other vessels. If you cut one off and examine it with a microscope, you will notice that around the axis is a thick cylinder, having numerous layers of soft, thin walled cells from whose epidermis (outer coating) project delicate, tubular membranes, known as root hairs, radiating in various directions among the soil grains and soil air-pockets. These hairs are covered with films of water; their walls in fact are saturated with it. As they absorb the water from the soil grains which they touch, there are little currents of water flowing towards the hairs in the effort to restore the equilibrium. They must of course reach down where the water is or fail to feed the hungry mouths above ground.

FUNCTIONS OF THE ROOTS.

"The whole surface of a root," says Prof. Asa Gray, "absorbs moisture from the soil while fresh and new; and the newer the roots and rootlets are, the more freely do they imbibe. Accordingly, as long as the plant grows above ground and expands fresh foliage, from which moisture largely escapes into the air, so long it continues to extend and multiply its roots in the soil beneath, renewing and increasing the fresh surface for absorbing moisture in proportion to the demand from above. And when growth ceases above ground, and the leaves die and fall, or no longer act, then

the roots gradually stop growing, and their soft and tender tips harden. From this period, therefore, until growth begins anew next spring, is the best time for transplanting, especially for trees and shrubs."

BALANCING FOLIAGE TO THE ROOTS.

It is laid down as a rule with all tree planters to trim back the branches so that the roots, more or less decreased by digging up, will not have to support more than their capacity will allow. Large roots of a tree serve more as anchors to hold the tree in place than life-feeders. The fine root hairs, which men are not apt to notice, are the chief instruments of support and this is a reason why the chances of success are greater in a small than large tree. When the absorbing surfaces of the root system have been diminished, especially in the root hairs, the evaporating surfaces in the foliage must be correspondingly diminished so as to maintain the balance between absorption and evaporation. The aim of the skilful pruner is to restore and preserve the natural symmetry of the tree. With a sharp knife cut off every marred root. This will aid in the healing-over process.

POSITION OF THE ROOTS.

In our naturally dry climate, the fibers of the roots should be made to dip down, screened as much as possible from the extreme drouth by bringing them nearer the moisture-grains of soil. The distribution of food, water serving as the solvent, has an important bearing on the production of roots as well as the position they assume. An interesting experiment, alike applicable to forestry as to agriculture, bearing on this point, was made by Knobbe, a German investigator. I am indebted to Profs. B. L. Galloway and Albert F. Woods for the statement: "He grew a number of corn plants in poor clay soil, contained in glass cylinders. In each cylinder of soil a certain amount of fertilizer was put, in each case in a different position, so as to observe its effect on the growth of the roots. When the plants were nearly four months old, the vessels were placed in water and the soil carefully washed from the roots. They were then suspended in water and took nearly the same position they had in the soil. Where the fertilizer had been uniformly mixed with the soil, the roots grew equally through the whole mass. Where the fertilizer was placed in a horizontal layer about an inch below the surface, there was a spheroidal expansion of the root system at this point. Where the layer was placed at the bottom of the vessel, the roots were slender and not much branched above, but at the bottom they formed a mat. Where the fertilizer was placed around the cylinder of earth next the sides of the jar, the external roots were greatly branched, forming a cylindrical nest, but the inner roots were not much developed. Where the fertilizer was put in a central verticle core, the inner roots were greatly developed, while the outer ones were much less so."

GAUGING THE WATER SUPPLY.

These facts and others of similar nature show the importance of root-position, especially in our northwest so liable to great variations in the water

supply, enabling us, in a measure, to control the character of our root systems. According to the given tests, we can no doubt, largely control the water supply by adaptable methods of soil cultivation and food distribution, where food is used. We must here bear in mind that the best development of the roots and of the plant, as a whole, is attained only when the water supply approximates a certain amount, and the amount will vary, of course, with different plants, soils, temperature, environment, etc. Too much water kills our trees and all plants in fact about as quick as excessive dryness. If the roots are produced in very wet soil, the trees die when the water dries out to any extent, sooner than if produced in drier soil. If the roots are produced in dry soil, they will not live long if the soil is made excessively wet for any considerable length of time. Thus sensitive are plants to their habitude; a fact ever to be considered in our treatment of them.

AMOUNT OF WATER FOR PLANTS.

The amount of water has much to do with the life and health of plants, varying in different species. Prof. Milton Whitney, Chief of the Division of Agricultural Soils, U. S. Department of Agriculture, furnishes the following in his report of 1894, p. 157:

"Plants may be likened to a pump, which must have a steady and sufficient stream flowing into the well, lest the surface of the water shall fall below the valve and the pump become inactive while there still remains a considerable amount of water in the well. There must be an adequate supply of water in the soil for the plants to draw upon, and this supply must be within their reach. To illustrate: a plant may wilt in a soil of close texture containing 10 or 12 per cent of moisture, because with so little water present in the soil, the movement of water to the roots of the plant would be comparatively slow, and the volume supplied per minute or per day would be insufficient; the plant would quickly exhaust the supply in the immediate neighborhood of its roots, and the amount necessary for its continued growth could not be pulled up from the surrounding soil rapidly enough to make good the loss. In a soil of different texture the same plant may not suffer until the supply falls to 4 or 6 per cent."

"Trees do best when the water in the soil amounts to from 40 to 60 per cent of the water holding-capacity. By such capacity is meant "the amount of water that a given weight, say 100 pounds, of the soil will contain when all the space between the grains of soil is filled with water. For example, a cubic foot of a very sandy soil has been found to contain about 40 per cent by volume of air space; when all this space is filled with water, the sand will contain four-tenths of a cubic foot of water. * * * The water holding capacity of heavy clay soils is about 44.2 pounds of water in 100 pounds of saturated soil. The most favorable condition of plant growing in such soils is when they contain from 16 to 24 pounds of water in 100 pounds of saturated soil."

TURGIDITY.

Turgidity is necessary to the growth of a plant, but its excess, occurring in very wet soil long continued, distends under pressure the cell walls out of proportion with their ability to construct new ones, and the whole plant soon becomes enfeebled, inviting the attacks of parasitic fungi which destroys it. The same fatality occurs when the water fails; the cells become flaccid, and the plant wilts and dies.

CIRCULATIVE ASSIMILATIONS OF COMPOUNDS.

The solid part of a tree consists of cellulose, largely carbon (44 per cent) of its weight with hydrogen and oxygen in about the same proportions as in water.

The carbon mostly derived from carbon dioxide (carbonic acid) of the air, which, under the electro-chemical action, mainly of light, is decomposed, the oxygen of the compound exhaled and taken up by the animal kingdom and the carbon imbibed by the plant kingdom and combined with elements from water taken up by the roots, and, by further chemical processes, which elude our art of comprehension, transformed into new compounds, such as sugar, starch, etc., which in turn pass down the outer layers just under the bark, ramifying every part of the tree clear to the tips of the root hairs, making new wood where these elements are deposited along the branches, trunk and roots.

TRANSPIRATION.

This circulating and assimilating process involves transpiration—passing out to the air. The term is often compounded with evaporation. A body of water, soil, dying and dead vegetation of every sort, oxidating stone and metal, everything containing water exhales vaporous gases. But transpiration is a life operation by which the plant grows, as just described.

AMOUNTS OF WATER TRANSPIRED.

The amounts of water transpired by trees vary with the species, age, quantity and condition of soil and light. Compared with quantity retained it is very large. It is estimated that one acre of forest may in one year, store up 1000 pounds of carbon, 15 to 20 pounds of mineral substances and 5000 pounds of water, and in the operation transpire from the soil to the air from 500,000 to 1,500,000 pounds of water. This is about half what is transpired by our agricultural crops. We can readily see what immense amounts of water are necessary to sustain vegetation.

QUANTITIES AND QUALITIES OF MINERALS USED BY PLANTS.

In this beautiful art of tree living and growing, small quantities of lime, potash, magnesia, nitrogen, etc., are taken up by the roots in a state of solution for food preparation, a cooking process, so to speak. As the water is transpired, the mineral substances remain in an electrically refined and vitalized condition, carried in the circulation to all parts of the tree as before described. Thus transpiration is succeeded by transformation, similar to what takes place in an animal body.

PLANT LIFE.

MOISTURE TESTS.

The problem in hand now presents itself: How to make available to our trees or other plants more of the water that falls. We have partially, at least, found the solvent, if we can decrease the evaporation from the soil and vegetations. Except where the soil is sandy, our prairie sods shed rain like a roof, more especially when rapidly delivered. Under reliable tests it is found that a plowed and cultivated field located beside one in its wild and unbroken condition, has a subsoil in a drouth season really moist, while the latter at the same depth is "dry as chips." Prof. Milton Whitney calls attention to an experiment he made at Geneva, Nebraska. "The soil and subsoil immediately under the prairie sod was so dry that it was difficult to take a sample with an auger, both because it was so hard to bore into and because the material loosened by the auger was so dry and powdery that it ran off the auger like fine, dry dust or sand. In an oat field, which had been thoroughly prepared by subsoiling two years before, the subsoil was quite moist, although the ground had not been actually cultivated for a year. In an adjacent field, which had been subsoiled the previous year, and during the present year had been thoroughly cultivated in nursery stock, the subsoil down to a depth of three feet was so moist that it could be molded in the hand. These three localities were not over a few hundred feet apart, and had been exposed to precisely the same rainfall, but had been subjected to these different methods of cultivation."

ERRONEOUS NOTION.

Much to the discouragement of tree planting with those who have not studied and applied the laws governing meteorological and soil conditions, the notion prevails and it is put on record, that where the maximum of annual precipitation is 20 inches, forest trees cannot survive. The facts prove to the contrary. Trees enmass can stand a drouth better than agricultural plants, because they plunge their roots deeper into the ground where the moisture is harbored. Trees are raised in arid portions of Kansas where the annual precipitation does not exceed 20 inches. North Dakota has but 18 inches, and that new state begins to vie with Minnesota in successful tree culture. Prof. Whitney thinks it possible that with improved methods of cultivation, the conditions actually existing in arid localities of the west, where the annual rainfall does not exceed 6 or 8 inches, "can be so utilized (without artificial irrigation) as to secure reliable and satisfactory crops," if so of course forest trees can be raised there.

VALUE OF DEEP PLOWING.

Speaking of the country at large, Hon. J. Sterling Morton, Secretary of Agriculture, says in his valuable report of 1894, p. 26, "Deeply tilled soils provide a large reservoir for the rainfall. The deeper the soil is stirred and cultivated, the larger the reservoir. The texture of the soil, that is, the relative amount of sand, silt, clay, and organic matter which it contains, and the way in which these constitutional grains are arranged, determines the amount of water which the soil may retain from rains."

PROVED BY CROP RAISING.

The value of deep plowing for tree planting has been repeatedly proved in crop raising. It has been found that a field deeply plowed and thinly cultivated will yield a crop 50 per cent larger than an adjoining field of the same size and quality of soil treated in the old way of shallow plowing and deep cultivation.

Prof. Babcock, of the Wisconsin experiment station, "found that a piece of unplowed ground lost in seven days in early May as much as 1,304 pounds of water per day, while in June the loss was nearly thirty-one tons daily, which was sufficient for the growth of one ton of dry matter of corn every ten days."

Prof. Sanborn, at the Missouri University, took two plats of corn, one-tenth of an acre each, and subsoiled one to the depth of sixteen inches; the other was plowed seven inches deep. "The former yielded corn at the rate of 70 bushels per acre and the latter gave 49 bushels per acre."

CAPILLARY FORCE.

By virtue of its own weight and capillary force, water is pulled downward when the subsoil contains less water than the soil. Such force is more effective in moving water through a moist subsoil than a dry one. Water descends or ascends capillary, very slowly in perfectly dry soil, but spreads rapidly in a soil which is partially moist. Understanding these laws, we can so manage our soil as to bridge over the drouth, promoting tree and other plant growth to satisfactory results.

ANALYSIS OF OUR SOIL.

In his analysis of our prairie soil, characterizing also large portions of the Dakotas and of the Great Plains, Hon. Harry Snyder, Professor of Agricultural Chemistry at the State Experiment Station, says, in the Northwestern European Edition of the Minneapolis Times: "In the central and western portions of the state the black soil rests upon a yellow (blue for the most western part along the upper Minnesota and lakes Big Stone and Traverse —Ed.) clay subsoil. The black top soil ranges from one to three feet in depth. These soils are unusually supplied with nitrogen and phosphates, the two most important elements for plant growth. The analysis of over 200 of these soils made at the agricultural experiment station of the University of Minnesota, showed an average of about .35 of a percent of phosphate (p. 205) and .30 of a percent of nitrogen. The lowest amounts of phosphates found in any of these soils was .21 of a per cent, while the highest amount was a .65 of a per cent." This exceeds the plant food of some of the cultivated soils of England. "The yellow clay subsoils are very rich in potash and lime. This makes an ideal combination as to plant food. The black top soil is strong in nitrogen and phosphates, while the subsoil is very strong in potash and lime."

It is plain that our soil constituents are such—clay being water-holding—

as to warrant complete conquest over the drouth, answering forestal survival and growth, when we apply the right methods of soil treatment for water economy.

MULCHING METHODS FURTHER ELUCIDATED.

According to Mr. Knobbe's experimentation, the best results of the fertilizer, as to position, obtained when it was equally diffused in the clay; the roots at every change always developing best when in touch with the fertilizer. It will be observed, where old orchards show signs of decay, and a manure mulch is spread upon the surface of the ground, that the trees send up little rootlet-suckers to get their wanted food, greatly reviving the trees. Sometimes these delicate rootlets, taking advantage of their liberty, "set up housekeeping on their own hook"—become new trees, thus robbing their parents of filial support. In times of drouth, despite the mulch, these surface-feeding rootlets suffer for water, to the great peril of the old trees depending on them for food.

It is obvious that if the manure, well rotted, were plowed under and the surface soil frequently cultivated during the summer, these rootlets would not be bobbing out of the ground, but stay where they belong, holding their own deep in the soil, escaping the fatality of the drouth.

DUST BLANKET.

Every observer will have noticed that a rain may fall for days upon a pile of dry manure and not wet it but a few inches down. This shows that a thick mulch of such material is of slight if any advantage to a tree so far as the rain is concerned, unless it should be long continued in gentle descents. A layer of surface dust is a different constituency, more compact and therefore more protective against evaporation. The manure is like an open, and very porous sponge, that will imbibe much less water than a very fine one of the same size, and will evaporate its water sooner. As water does not readily spread through dry soil, a saturated layer may remain beneath or adjacent to it for quite a length of time. The special value of the "dust blanket" can be better appreciated by its application to any kind of plant culture.

SOIL PREPARATION EXTENDED.

Dating from the preceeding facts of stern experience, it is obvious that we must, so to say, box up the rainfall in our soil, so that the roots can use it economically, secure from drying winds and suns. As already stated, the wild soil must be first subdued, the sods well turned, crops of grain or potatoes raised for a few years on the field, the culture killing out all the grass and weeds. The plow should go at least an inch deeper each year. Our prairie is naturally rich enough without manure. Where places, which the trees used to occupy, are cold and sour and barren, better use some rotted manure well worked into the soil. It would be a decided advantage to sub soil the fall before the spring planting, loosening the soil nigh down to the semi-hard pan. If farmers would do this, having a loosened-up bed of soil from eight to twelve inches deep, other conditions equal as hereafter de

finer, the common failures in tree raising would be the exception and success the rule. The clay subsoil of the prairie does not leak. The water is kept at the bottom of the humus; and the "dust blanket" frequently combed by the fine teeth of the cultivator, deeper in the early season, shallow in mid-summer, will cut off the egress of water by evaporation at the surface. The extra cost of such a soil-bed for trees will pay, as experience proves.

IRRIGATION.

The methods of plant culture here presented with such assurances of success when applied, should not lessen the growing interest in irrigation. There are localities in our state where it is feasible and practical. It is proving a success when wisely managed on small areas, more especially in the mountainous regions of the country. But to keep up the old methods of soil treatment on our open prairies, run behind, and then resort to the heavy costs of irrigation, is a spendthrift's policy. If it is possible for us to save at the bung where we have so long been losing, giving forestry "a black eye," had we not better mend our ways, think? Our safety lies in soil conservation of water. It is doubtful if irrigation in Minnesota will pay when applied to forests on a scale corresponding with the needs of the people. We can raise trees without it in almost every part of the state, only manage rightly.

MECHANICAL IRRIGATION.

The following estimate of the value of irrigation clipped from *Farm, Stock and Home*, means to include tree as well as the other annual crops of the farm. Economizing the rainfall by deep plowing and next irrigation with forestry, where it can be necessarily and practically applied, are the two co-factors of the people's prosperity.

"Irrigating small tracts of land by raising water with wind mill or other power is entirely practicable. A thousand barrels of water will cover an acre to the depth of an inch. The Irrigation Farmer, of Kansas, reports a case of an 8-foot wind mill with a common 2 inch pipe and a brass-lined pump, cylinder 4x14 inches, 12-inch stroke, irrigating nine acres of garden, from which a whole family was supported, and left a profit beside. The water was pumped from a 51 foot well into a reservoir built in a knoll enough above the ground to be irrigated to flood it. The reservoir in this case was 100 feet square, and built of earth. It cost nothing but labor. An 8 inch pump and a 12 foot wheel will lift from a well 20 to 50 feet deep 65 to 80 gallons a minute, with an ordinary wind. This would be water enough pumped in about eight hours to irrigate an acre with an inch of water. And since, with good cultivation, that depth of water would keep crops growing nicely for many days, it will be seen that such an outfit would prove one of the most profitable investments on the farm. This subject becomes a very important one when considered in the light of the fact that 10 to 15 acres of well-watered land may produce more in a season than a quarter-section, drouth-stricken farm."

LESSON OF NATURE.

In treating our soil so, and planting trees so, we are in fact copying nature's methods ever sure of success. By winds and birds and innumerable rodents she plants her forests where she can. The roots dip down deep, opening and loosening the hard soil better than the plow and cultivator, for they are permanent conduits for the surface water to filter into the pockets and chambers of the ground safely conserved for the root hairs to drink and carry up for wood structure. Then she covers with the best mulch in all the world—the healthful air and water-holding leaves that prevent undue evaporation, whose eventual decay feeds the trees in turn and makes a soil for future agriculture. She thus not only waters but shelters and enriches the soil with humus, but checks the winds, transpires humidity upon the air to green all the landscapes near and afar, and forms the lakes and rivers that are necessary to our farms and homes as are the heart-pools and veins to the human body. The lesson to learn and practice, then, is the lesson of forestry.

MANAGEMENT OF FOREST SEEDS AND TREES.

Forest seeds procured from the most reliable seed stores, warranted to be fresh, may have been subjected to unseen influences, such as partial decomposition in transit or other causes, losing the germinating power. The farmer should try and raise seed-bearing trees, and then he is sure to be safe in germination, if he attends to other necessary conditions as herein stated; and he should have a little forest nursery of his own, on the principle that forestry and agriculture are inseparable.

DURATION OF GERMINATING POWER.

The duration of the germinating power of forest seeds is generally for a very short period, sometimes but a few months or even weeks, depending on circumstances and conditions, whether they are kept in their husks under cover or in the ground, secure from dampness and heat. With proper treatment, seeds of the hard maple, ash, box elder, basswood, pine, all of which mature in the fall, can be kept one year, or safely till the next spring.

PRECARIOUS SEEDS.

Seeds of the poplars, including the cottonwood species, the willows, the elms, some birches, soft maples, etc., lose their power of germination soon after ripening in the early summer. Those of the oaks and other nut trees, maturing in the late fall, are also delicate keepers. As a rule all such species better be planted soon as gathered.

SEEDS TO FREEZE.

All seeds that take from one to two years for their germination must be allowed to freeze; hence the importance of sowing them in the fall soon as ripe. To summarize, they are seeds of the oaks, hickories, hard maples, chestnuts, sumachs, alders, barberries, junberries, buckthorns, hawthorns, dogwoods, hazelnuts, beeches, ashes, junipers, cedars, plums, pears, apples, elders, basswoods, ironwoods, box elders, hackberries, buffalo berries, locusts, hollies, etc.

VITALITY OF CERTAIN SEEDS.

Because seeds, under ordinary circumstances, generally fail to germinate after one or two years, it does not follow that methods cannot be devised by which to preserve their vitality for indefinite time. Where seeds are locked under the eternal snows of the polar regions, they may not have lost their germinating properties. Bring them into a clime as sunny as that which produced them in the unknown ages of the past, and they may quicken into life. Grains of corn and wheat, resting for centuries in the folds of Egyptian mummies, have been lately planted, and lo, they sprout and mature identically perfect as in the days of the Pharaohs. There are deserted river-valleys in the Sahara desert; these and other evidences prove that desolate waste was once covered with magnificent forests and vast populations advanced in civilization. They did what men are doing now—destroyed the forests; since which the sands from the sea shores and mountains have deeply buried that tropical region for many centuries. In sinking artesian wells there, the seeds of the ancient flora are thrown up by the water, which, under sunlight and moisture, germinate, and vegetable history repeats itself. Earthquakes have brought to the surface a soil, buried for ages, which on exposure to the sun, gives birth to new and strange forms of plant life. Lindley, in his *Botany*, page 358, mentions raspberries "from seeds taken from the stomach of a man whose skeleton was found thirty feet below the surface of the earth, at the bottom of a barrow which was opened near Dorchester, Eng. He had been buried with some coins of the Emperor Adrian, and it is probable that the seeds were 16 or 17 hundred years old."

When the virgin soil of our prairies is plowed, a vegetation springs up very unlike that of the unbroken soil. The seeds of such must have lain a long time under the matted turf. Where a territory is densely covered with a special class of trees and shrubs, the shade stops seed germination.

These cases among the many, show that, by some artificial and cheap contrivances, we can reduce to something like certainty the preservation of valuable seeds for long voyages and periods of time. Prof. Lindley states that seeds brought from India, round the Cape of Good Hope, to our northern climes, "rarely vegetate freely;" but when brought overland, and not exposed to the sea fluctuations of temperature, they generally succeed. Dating in actual tests, he recommends for long and safe preservation of seeds to surround them "with many layers of non-conducting matter, as case over case of wood, and by ramming every other space, in such cases, with clay in a dry state."

POOR LUCK WITH COTTONWOOD SEEDS.

Generally attempts to raise trees from cottonwood seeds prove abortive on the prairie. Better depend on their self sowing on the low sand beaches of lakes and rivers. You can aid the process, just before the cotton-incased seeds fly out of their tarry pods, by harrowing the wet sands till made soft and friable. Millions can thus be raised at little cost.

SEED SELECTION.

Seeds inherit the conditions of their parent trees. If the trees are stunted, malformed, old or decaying, like qualities will in time show themselves in the offspring. The same laws obtain here as in the animal kingdom. Select from the middle-aged, where they are standing out quite single and exposed, having the full benefit of circulation and sunshine. The larger seeds generally produce larger and healthier plants.

QUALITY TESTS.

Sometimes seeds appear all right. Break some open and see what percentage is hollow-hearted or measly. If sound, gather when the weather is dry and they begin to fall. Take a handful at random and test them in water. The sound ones sink. Plant some in a pan of damp soil, kept warm, and notice how well they sprout. Soaking in lukewarm water, for a few hours or a week, according to their refractory make up, or by steaming, or pouring boiling water on them, accelerates the sprouting.

ESSENTIALS FOR SEED QUICKENING.

Judging from the duration of the germinating power of seeds long buried in the earth, and other circumstances, the essential conditions for their preservation are uniform temperature—moderate dampness—exclusion from the light.

DRYING FOR SPRING PLANTING.

If the seeds when gathered are yet somewhat green, do not let them remain long in the sacks—not even over night. Spread them out thin on a floor under cover, where the air circulates well, and rake them over once a day, until the dampness has evaporated. When properly dried so as not to heat, place them in gunny or other very porous sacks, intermixed with dry sand, or separated in quite thin layers between dry leaves, and hang them up under airy shelter.

SOAKING THE SEEDS.

Seeds thus kept over, such as the box elder, ash, basswood, hackberry and other refractory fellows, must first be soaked by the swifter methods mentioned, or in running or in frequently changed water till well swelled out almost ready to sprout. The ash requires longer soaking. The soaking will not be necessary if you have preserved the seeds stratified, (spread out thin) just before winter sets in, on a smooth and well drained spot of ground, covered with boards, sand, decayed straw or other litter, and there kept frozen and moist.

PULPY SEEDS.

Buffalo berries, cranberries, cherries and others of like constituency, should be planted, when mature, where they are safe from the depredations of rodents. They can be kept over till spring, by the out door ground method just described. See that they are kept from drying the least in the spring, and plant soon as the ground is well warmed up and in moist condition.

HARD SHELL SEEDS.

Seeds of the juniper, locust, white and red cedar, hawthorn, Kentucky coffee tree and the like are difficult to sprout. If planted in the fall, locate them where they can have the utmost vigor of wintry freezing and thawing. Try the boiling water process till the shells show signs of cracking, and alkali of potash on the red cedar seeds, which seem to be the most refractory of all. (See article of Evergreens from Seed.) If you want quick results, after applying the boiling water, or alkali, mix the seeds with damp sawdust in a vessel, kept in a warm place.

SOIL CONDITION.

Grow a crop of potatoes on the field or bed where you want the seed planted, with such culture as will exclude all weeds and grasses. Plow just as deep for the seeds as for the seedlings; pulverize fine. (See article on Value of Deep Plowing.) Do this in the fall, so that the soil will be sufficiently compact to hold the future roots close and conserve water evaporation. This preparation must be made with the utmost care for the seed, irrespective of the season of sowing.

SOWING THE SEEDS.

On large areas put the seeds in rows from two and a half to three feet apart, to give room for the horse cultivator. In beds, where hoeing is to be done, have the rows much closer. Select a calm day for the sowing of winged seeds, especially such as the box elders, maples and ash. You are to sow the seeds dry in the fall; wet in the spring and while the soil is somewhat moist. Do not do this work during wet weather, for then particles of sticky earth may adhere to the seeds, retarding vegetation. Cover as fast as possible and thus avoid the drying out of the spring-sowing seeds.

THIN SOWING.

Comparatively thin sowing of good, healthy seeds produce large and profitable seedlings. Thick sowing may yield you poor, dwarfed seedlings, whose stems are about the size of knitting needles, and half dead at that.

DEPTHS OF SOWING.

Covering too deep is hurtful to germination. Medium depth, according to size of the seeds, should be the rule; deep for larger seeds, thinner for smaller ones. Some recommend a depth equal the diameter of the seeds.

For maximum depths, some $1\frac{1}{4}$ to $2\frac{1}{2}$ inches for oaks and chestnuts;

$\frac{3}{4}$ to 1 inch for maples, ash and box elders; 2 inches for locusts; $\frac{1}{8}$ of an inch for alder; $\frac{1}{2}$ to 1 inch for spruce, Scotch pine and larch; $\frac{1}{4}$ of an inch for white and Austrian pine; birch and elm as thin as possible to ensure germination. Thinner sowing of any of these seeds is practical where the soil remains or can be made moist. Fall sowing may be covered more heavily.

LOOSE COVERING.

See that the covering is reasonably loose for air and moisture circulation to dissolve the food materials in the seed, and for the co operative sunshine to develop into new life. The less danger to the seeds occurs when the sprouting is quick and vigorous. Shield the seeds from hot air and strong light as much as possible. This you can do where you sow in beds, and you can also supply water at the roots when necessary, and largely regulate the light and heat on the tender blades. Too much water on the seeds or plantlets may cause them to rot.

TENDING THE SEEDLINGS.

When the seedlings peep out of the ground, mice, moles, crickets and other depredators are sure to be on hand to destroy them. Grubworms gnaw at the tender crowns; ants and other insects, some of them scarcely discernible by the naked eye, suck the very life out of the roots and stems; others eat up the leaves.

What is the remedy? Try wood ashes sprinkled on; it helps; so does sawdust wet with carbolic acid. Make a weak solution of Paris green or kerosine emulsion, and sprinkle on the leaves.

KEEPING OUT THE WEEDS.

It must be done or losses ensue. Where the seeds were sown broadcast on the beds, of course they must be pulled up by hand and at as young a stage of their growth as possible. If they were put in rows, the hoe comes into play very handy and effectual. On the field of seedlings coming up in rows, the cultivator soon dispatches the greater part. In with it just as soon as the weeds peep up.

RAISING EVERGREENS FROM SEED.

"Good seed must be procured of the previous season's crop," says Chas. F. Gardner, of Osage, Iowa, a reliable nursery man of twenty five years experience. "Avoid seed that is old. Make examination and see that the germs are plump and sound. The seeds of the pines, spruces and firs can be tested in the winter the same way you would test wheat, oats or barley, to find the number of grains that will freely germinate in a given number of seeds. Seeds of the evergreens mentioned should be kept in a cool, dry room until time to plant arrives. Soak in warm water from twenty-four to thirty six hours before planting. Seeds of the arbor vitæ should be stratified as soon as picked from the tree; drying destroys their vitality. Red

cedar and juniper seed should be stratified as soon as gathered and remain in the stratified state one year before planting."

He recommends the same preparation of soil as herein given—deep fall plowing and pulverizing in the fall, and in about a week thence throwing the ground up in rough beds running east and west, making them, when finished, four feet wide and four to six inches above the ground level, the alleys between being two feet wide.

COVER FOR THE SEEDS

"Set good strong posts eight feet apart each way over the entire ground to be planted. Set them from $2\frac{1}{2}$ to 3 ft. in the ground and seven feet high from the ground up. Brace the outside row of posts all round. Then run heavy galvanized wire on top of each row of posts, north and south, and east and west, fasten securely on top of each post where the wires cross. Cover the whole top with common wire-lath fencing, made with one twist of wire less than common between the lath and bring them close together. Enclose the sides in the same way, fastening everything securely with staples to the posts. Instead of using lath, brush can be used by placing the wires two feet apart, and weaving and tying brush to them. The shade must be evenly distributed so that half or little more than half of the rays of the sun will be intercepted.

SIZE OF BEDS.

"After finishing your shading, go all over your beds with a cultivator and then let them alone till spring comes and the ground is dry enough to work well. In the spring scatter a liberal dressing of wood ashes all over the beds; then pulverize thoroughly to the depth of four inches; finish making the beds, having the edges straight, and the beds four feet wide and an inch or so higher in the middle than at the edges.

MANAGING THE SEEDS.

"Sow broadcast and have three or four seeds to the square inch. After sowing a bed, run a common sized roller over it until every seed is pressed firm into the soil. Cover the whole bed with light colored, fine, clean sand to the depth of one quarter of an inch for the spruces, Scotch pine and firs, and about one-half inch for seeds like white pine.

"Red cedar and arbor vitæ seed is taken from the place where they are stratified, and sown sand and all, then rolled and covered as the others, with the exception that the arbor vitæ is just barely covered with the sand and pulverized dry moss is sifted over them to a depth of a little less than one quarter of an inch, and the bed carefully sprinkled with water through a fine hose. After every rain the beds must be looked after and sand applied again wherever it has washed off. The seeds germinate from ten to twenty days after planting. All weeds must be pulled out by hand as fast as they appear as the beds must be kept perfectly clean. The object in having the sides enclosed as well as the top is to keep out rabbits, dogs,

poultry and other predators. A dog or rabbit merely walking over a bed when the trees are coming up will destroy thousands.

SPRINKLING THE BEDS.

"While the little trees are coming up, if the weather is dry, the beds must be carefully sprinkled every evening. Use just enough water to thoroughly dampen the sand on the beds. Have some dry sand stored away, so that during long spells of rainy, damp, foggy weather, you can sprinkle the beds with it after each shower. This coating of dry sand should be very thin, not over one-thirtieth of an inch deep. Pull out the weeds before they form the second set of leaves. Keep the alleys clean with the use of a hoe.

DISTANCE FROM SHELTER BELTS.

"The ground occupied by the seed beds should be at least six or eight rods from any building, trees, hedges or other windbreaks. A windbreak is a good thing to have round your seed beds, if at a proper distance. I prefer a distance of about twenty rods or more to secure good air drainage. The beds must be constantly watched until the little plants have formed their true leaves. The most important objects to keep in mind are,—1st. The birds must be kept off. 2nd. The weeds and grass must be pulled. 3rd. If the weather is too dry sprinkle, if too damp use the dry sand.

FALL TREATMENT.

"After the true leaves have formed, the plants require but little attention except that weeding must be kept up. When the ground begins to freeze in the fall, cover all the beds with wild hay; use just enough to cover them, and no more. This is removed the latter part of the following April, and the trees will require no attention during the summer except to be kept free from weeds. The next fall treat the beds to another covering of hay, and the following spring you will have, if you have closely followed my directions, in spite of possibly some severe losses, 2,000 or more trees on each four feet length of bed, two years old, and from three to ten inches in height, ready to be transplanted."

NUT PLANTING.

An experienced writer, in Garden and Forest, gives the following valuable instruction for nut planting: "The acorns of the white oak, *Quercus alba*, for instance, often crack and sprout and show the so-called root before the fruit falls from the tree. If these acorns are gathered and allowed to dry for a few weeks before planting, it is unlikely that any of them will grow. The same result follows in nature, if they fall on ground that is hard and dry and continue so for some time afterwards; but if the ground is moist the radicle or incipient root will soon enter it and be secured from drying, unless the soil itself should be deprived of moisture. What is true of the white oak is true of other species, although often in a much less marked degree. Some of the black oak group, for instance, bear acorns which are slower in germinating and appear to preserve their vitality better under adverse conditions.

METHOD OF PRESERVING THE NUTS.

"It is destructive to the vegetative power of all acorns collected in the autumn to keep them uncovered in an ordinary dry room to be planted in spring. But any of them may be preserved for months, if simply packed with moist, but not wet sand, soil or moss, and kept in a cool temperature, such as would prevail under a light covering of leaves or soil in the open air. Similar treatment must be given to hazelnuts, chestnuts and beech-nuts. In all cases care should be taken to mix in plenty of soil, or to place the nuts in layers so that they do not touch each other, and any tendency to heat and consequent moulding should be guarded against. Butternuts, walnuts and hickory nuts will not grow readily, or at all, if allowed to become thoroughly dried or cured, although the kernels may preserve a fresh appearance for years after germinative power is lost. They will, however, keep their vitality much better and longer than acorns under the same conditions.

"As a rule, direct planting in the open ground as soon as the seed is collected is to be preferred, whenever practicable, for most kinds of nuts and acorns.

PREDATORS.

"Among objections to this system are (1) the liability of the larger nuts to destruction by squirrels, of the thinner shelled ones by mice and some other rodents, or by birds; and (2) the action of frost in heaving the nuts out of the ground. Where the predators can be guarded against, the heaving action of the frost can be obviated by a covering of leaves or boards laid over the seed. Some growers aim to plant after hard freezing weather has set in, because there is then less liability to disturbance by animals. In this system of planting an extra quantity of seed is required to allow for failures or mishaps, just as is the rule with many field crops.

BETTER PLANT THE NUTS.

"Walnuts, hickories and oaks generally form long tap roots, and some persons consider it an advantage to have the seed planted where the trees are to remain permanently, as it is generally found expedient to cut the tap root when transplanting. When the seed is planted where the tree is to remain, experiments have shown that these undisturbed trees make a much faster growth, in their early years at least, than those whose main roots have been cut."

THINNING OUT THE SEEDLINGS.

Despite the precaution the seeds are apt to come up too thick. If so, pull out the superfluous plants, when about four to six inches high. Don't leave the "fittest" crowding and choking each other. But save what is not wanted in those rows. Why not? They cost too much and are too precious to throw away. Fast as pulled, put them compact in a pail or tub of water. Under some shade cut the tap roots off about two inches, and immediately

plant in newly prepared beds. Shade and water them vigilantly. Start them that very mid-summer, growing again, well thinned. There is a way to do this and not lose them.

REMOVING THE PLANTS.

If rightly cultivated, thinning as the season wanes, stopping about the middle of July so that the cells can have time to ripen for the winter when the leaves begin to fall in October, your trees are plump and large, and sound to the very tips. They may be in a good condition to endure the winter, protected by the snow, trapped by the weeds, then sprouted up after you housed the cultivator. But with the best of care, one year old seedlings are apt to be tender and liable to be hurt by freezing and thawing wintry nights and days. If you want them for the market or replanting on your own or neighbors' grounds, next spring, better remove them in October. Avoid pulling them up; it breaks too many tops and roots, and strains your back, too. Start the roots with a well scoured spade, or the tree digger's knife, like a plow drawn by two horses astride the row, cutting the soil just under the roots; in either method leaving the trees yet in the ground. Then they are easily taken out, classified and counted, under care not to expose the roots.

HEELING-IN.

Select a well-drained spot; dig a trench of suitable length and depth corresponding to size of your trees. Throw the dirt up like a roof. With a sharp knife cut off all broken and badly bruised parts of the roots. Thin out the plants side by side in the trench, their stalks lying impact on the slant. Sprinkle the dirt among the roots fine; shovel on enough for another ground-roof and another tier, and so on till all are buried. Press the earth down gently. After the ground is well frozen, cover the tips with some kind of litter. By spring the cuts and broken parts of the roots have started to heal over, and you have saved so much time.

SAVING FROZEN PLANTS.

If by any mishap, plants get frozen, when out of the ground, place them immediately in a dark cellar and allow the frost to come out slowly. Any frozen plants, flowering as well as small fruits, can thus be restored to vital healthfulness, if done before any thawing in sunlight occurs.

REPLANTING IN THE SPRING.

The soil must be in proper condition as described, before a single tree is taken out of the ground, and the tools put in order. Wait until the frost is out of the way and the soil is warmed and electrified by the sun. Plant nothing while the ground is in a mortar-like condition, or when the water will collect in the hole. If you do, the soil particles will harden on the roots, greatly injuring the growth. A warm, moist soil is one of the sureties of success.

As the trees are taken out of their heeling-in bed, with that sharp knife,

again cut off all decayed and other unhealthy parts of the roots. Mix cow manure, clay and water in about equal proportions, and puddle the roots. Do not even then expose them to hot winds or suns. A little carelessness in this respect may lose one half or more of your trees. Use a spade or shovel fork in planting. Spread the roots out natural, insert an inch or two deeper than they grew, and with a downward trend to be safe in the moisture when the summer drouth comes on. When the soil is properly worked impact among the roots, press the earth firmly around the plant, and with a flip of the tool leave a thin layer of loose dirt on the surface.

SAFE CULTIVATION.

Again attention is called to the cultivation of trees, applicable alike to all other plants. We have been considering the needs of one-year seedlings, say ash, box elder and other deciduous trees. In a few days weeds show their impious heads. Drag the harrow right over the trees, before the leaves have unfolded. It will destroy the weeds, and help the trees the same as it does for the sprouting of potatoes. You can safely do this two or three times, and save much hard labor. Stop that kind of business when the leaves forbid you. Then follow with the cultivator, killing the weeds and grasses, stirring and aerating the soil, thin, thinner, thinnest fast as the summer days come and go. Do not prolong this necessary work beyond the middle of July, as before stated. About that time the cells of the plants have attained their full development. Let them have a chance to ripen and be able to face the music of Old Boreas. Let the new weeds grow. They and the snow are providential now.

PLANTING EVERGREENS.

What is necessary for deciduous trees in respect to preserving them from the damaging effects of exposure, is imperative in handling evergreens. Bright drying suns and winds gum up the roots and limbs which stops the circulation and kills the plant. Do not expose it a single minute. Plant and cultivate as instructed, except the harrow must not be dragged over the evergreens. There may be hours and days when it is necessary to shade them.

SIZE OF EVERGREENS TO PLANT.

For field planting where the cultivator must be used, better put in evergreens from six to twelve inches high. For the lawn or a shelter belt against the wind, saving time of growth, trees that are not over three feet, and such as are nursery grown and well rooted, are recommended.

CUTTINGS.

If the season ensures moist ground, cuttings may prove a success. Millions of willows, cottonwoods and other poplars have been annually propagated in Minnesota. But it is not the surest way as a rule. Success has sometimes followed if cut in the late fall and buried for spring planting. If you have the trees handy, cut in the spring just as the buds begin to

swell, and put in the ground immediately. Select the limbs or shoots of last year's growth that are well ripened up. Cut from 8 to 10 inches long. Sink them into the ground well nigh to the tip. Press the earth around tight. Cultivate as you do the seedlings.

SURER WAY OF SPROUTING CUTTINGS.

Plow furrows eight to ten inches deep, and, while the ground is fresh, bury your cuttings and even long poles, notched here and there for points of sprouting, and plow them under. This method keeps the cuttings down in the moisture, where they are less endangered by dry weather.

ELIMINATING THE ALKALI.

Speaking of the ill-luck some men have in raising the cottonwood on certain kinds of soil, Col. John H. Stevens, a veteran forester, says: "It will not live in soil strongly impregnated with alkali; but when this element is eliminated by culture long enough, we shall have better luck with this tree" No tree can be healthy and be compelled to fasten its roots in such soil. Alkaline water hurts them as badly as it does a human being. The following couplet is ever an applicable truism:"

"No culture without forests;
No forests without culture."

PLANTING LAWN AND STREET TREES.

In planting trees that range from eight to ten feet high, select from the nursery grown, if possible, such as are symmetrical, and well foliated. Retain as much of the mother dirt impact in the roots as possible, and preserve the little fibers and root hairs, for these are life-supporters. In removing, cover with moist bags or mosses. The usual method of treatment is to lop off the whole top, leaving nothing but a bare pole.

It is then an unsightly thing, and generally has unsightly limbing—too thick and ring-shaped. A better way is to select trees that are grown more in the open, having stronger and less spiring trunks, that will not need to be decapitated, and prune them for health and beauty the year before transplanting, so that you can give them some lungs at the start. Then they will shape themselves to order and be a joy of perspective as long as they live; and they will be more likely to live then. The practical method of planting such trees, and the aftercare, are thus summarized by Prof. Fernow, Chief of the Forestry Division:

"Holes are best made before the trees are brought to the ground. They should be some deeper than the depth of the root system, but twice as large around as seems necessary, to facilitate penetration of rains and development of rootlets through the loosened soil. Place the top soil, which is better (being richer in easily assimilated plant food) to one side, the raw soil from the bottom to the other side; in filling back bring the richer soil to the bottom. If it be practicable, improve a heavy, loamy soil by adding to and mixing with it looser sandy soil, or a loose poor soil by enriching it with loam or compost. Keep all stones out of the bottom; they may be used

above the roots, or better, on the surface. Providing proper drainage is the best means of improving ground for tree planting. Use no manure except as a top dressing.

WATERING THE TREES.

"The practice of using water while planting can hardly be said to be a good one, unless the water is very carefully applied with a 'hose' after the soil is well filled in and packed around the fibrous roots. Water, after the transplanting (and perhaps before the last shovels of earth are filled in), especially if the soil was dry, is useful and should be applied during the hot season, choosing the late afternoon or evening for applying it. Any mulch of waste material, straw, or better, wood shavings or chips, sawdust, or even stones simply placed around the foot of the tree, is of excellent service in checking evaporation."

Stay the tree firmly; tie so as not to injure it; encase it in a box or heavy wire-netting; chastise the man who makes it a hitching post, or the boy who uses it for a climbing pole.

TRANSPLANTING LARGE TREES.

In transplanting large forest or fruit trees, first dig the monster holes the fall before planting, where you want the trees to stand. In the fall dig a round trench three or four feet from the trunk of the tree, going some depth below the roots; see that the trench is drained of standing water. When the disk of earth enclosing the soil has been frozen into a solid mass, it may be pried up, without disturbing the roots, and the whole removed by a team to a new site with but little difficulty. A large coarse canvas is generally tied around the roots while in transit. In Minnesota they are usually transplanted in the early spring, while the snow is on the ground for they can then be more easily handled. By tackle-and-fall they are placed in their holes and the dirt filled in compact. The trees are stayed with heavy timbers or wires, so as not to chafe the bark. When they wake up some sunny morning, they don't know that anything has happened, except changed to more aristocratic quarters.

ADAPTATION TO CLIMATIC ENVIRONMENT.

In selection, do not calculate that because trees in the native forests grow on the same parallel of latitude or about the same altitude as where you live on the open prairie, that they must be adaptably hardy. Enduring and resisting qualities are wonderfully modified by dense companionship. Trees from the nursery, more or less exposed to the winds and storms, are far hardier and contain more assurance of surviving the removal, because they have more fibrous roots and hardened up foliage.

We should calculate for our trees as we do for our agricultural seeds—study the local ranges, the rainfall, the temperature, the atmospheric

NOTE.—In transplanting large trees the dirt dug out in the fall must be thrown back to remain until spring.

humidity. From naturally wet soil to a dry, or the reverse, is not adaptable. Correspondences in essentials are one of the guarantees of success. Trees or seeds from cold and dry regions possess hardy qualities. Some of those well meaning fellows out West gather seeds of the Douglas spruce for instance, from the humid and semi-tropical Pacific Slope, and sell them to our prairie people on the claim of adaptability. Failure is certain. That species of spruce is to be sought, but it is the unfit, unless the plants or seeds are collected from the dry, cold regions of the Rockies. Toughness, tenacity, durability—these qualities inhere in seeds and plants in exposed and trying localities. In this respect a marked difference obtains even in our state. We should always calculate for environment in our selection.

ADAPTATION OF MINERAL CONSTITUENTS.

The granular structure of the soil, the movement of water in it, the depth and moisture conditions in respect to the roots—all such matters are of great importance in plant life and growth. The mineral constituents must be earnestly studied with an eye to success. The ash will grow in almost any soil, feebly if cold and sour; but the better way is to "tame" it to order by culture and fertilization.

The black walnut or butternut may soon perish in such soil; it calls for rich, deep, moist, warm soil; so does the box elder, the soft maple, the bass-wood and all light-needing species.

The cottonwood will soon give up the ghost in a thin, dry soil. You can trust the ash there, but it asks for room to send its tap root down to the moisture.

Most of the oaks need well drained soil; the swamp white oak thrives best in a wet, alluvial soil; clay is a help to it.

The black jack and bear oaks do well on barren lands.

The red flowering maple clings to the alluvial low banks of the rivers.

The hard or sugar maple flourishes best on the hilly sides, in soils that are stony but fertile, cold and humid.

The birches, especially the white and so the poplars, do well on the burnt districts, but more secure under leaf mulch.

The woodland arbor vitæ will thrive on the swamp knolls, and even on shaly stone where the soil is but a mere skim, if plenty of shade is over it and the water-drops ooze under the leafy humus; but has to struggle for life if transplanted into the rich and drier soil of the open prairie, but does well here if first acclimated in the nursery.

The pines and spruces have a wonderful capacity of adaptation to different soils; will even live on ledges, if they can penetrate their roots into the crevices filled with damp soil washed in from the hillside.

The bull and jack pines will grow and do well in sandy soils.

ADAPTATION TO THE CORNFIELD,

Using good common sense, some of our prairie farmers plant their seedlings in the alternate spaces of the corn hills, thus putting the trees eight

feet apart with a hill of corn between them. This arrangement affords clean culture and just the right amount of shade. The cornstalks are allowed to remain on the plantation through the winter. Next spring new trees are planted, leaving them in rows four feet apart. The method is a success.

ADAPTATION TO SITE.

Every orchardist knows that apple trees do best on northern slopes; better on eastern than on western or southern slopes. In South Africa the southern slopes are preferable, for the winter in the south temperate zone occurs there when it is mid-summer in the north temperate. The same advantages occur to most of forest trees when planted on the more shaded places, where they can better shelter themselves from hot winds and be less liable to sun-scalds. The slope, if any, the aspect, or exposure, the surroundings have a potent influence upon the local climatic conditions. Variations in soil-mixture and exposures to forests are special characteristics of hollows and other low lands.

MIXED PLANTATION.

From these data it is plain that a mixed plantation of trees, properly balanced for shade, made up of several kinds adapted to the soil, have many advantages over a pure plantation, made of one kind. It is more picturesque, more preservative of soil conditions, requisite to mutual growth, and less liable to injury from fires, winds and insects, and more readily reproduced when thinned out.

SELECTION OF THE "FITTEST."

Dr. H. A. Tomlinson, superintendent of the St. Peter State Hospital, writing the author, inquires in respect to "the kind of trees best suited to this locality of the state, for foliage and hardihood, and also what flowering shrubs there are which will grow in the climate of Minnesota. "We have on the grounds principally, elms and box elders, and we would like if possible to increase the variety of trees. * * * Concerning the shrubs, I would like to secure a sufficient variety so as to have them come in bloom successively; so grouping them that the bloom of one variety would succeed that of another over a considerable period in the spring."

The lists here given are not based upon latitude or elevation, but upon actual tests in divers soils and under trying influences of environment. It is believed that most of them will do well at St. Peter and the regions there about. Attention is respectfully called to the preceding article in respect to the laws of adaptation.

TREES RECOMMENDED FOR GENERAL PLANTING.

Green Ash, *Fraxinus viridis*; any good soil; seed ripe in Oct.

White Ash, *F. alba*; Oct.

Box Elder, *Negundo aceroides*, reliable; Sept.

White Elm, *Ulmus Americana*; clean, majestic; June.

White Willow, *Salix alba*, rapid grower; June.

Cottonwood, *Populus monilifera*; needs moist soil; June.
 Bur Oak, *Quercus macrocarpa*; wants rich soil; Autumn.
 Jack or Bear Oak, *Q. Banistera*, for windbreak; Oct.
 Butternut, *Juglans cinerea*, desirable; Oct.
 Black Walnut, *J. nigra*, southern half Minn., valuable; Oct.
 White Pine, *Pinus Strobus*, lumber tree, handsome; Nov.
 Scotch Pine, *P. Sylvestris*, coarse, very hardy; Autumn.
 Bull Pine, *P. ponderosa*, promising; Autumn.
 White Spruce, *Picea alba*, better than Norway; Autumn.

ORNAMENTAL TREES RECOMMENDED.

Soft Maple, *Acer dasycarpum*, protect, shorten the limbs; June.
 Sugar Maple, *Saccharinum*, succeeds when established; Oct.
 White Birch, *Betula papyracea*, always pretty; Autumn.
 Yellow Birch, *B. lutea*, golden bark; Autumn.
 Cut Leaved Weeping Birch, *B. alba var. laciniata*, hardy in good soil; Autumn.
 Bitternut Hickory, *Carya amara*; also Shell Bark and Pig-Nut; Autumn.
 Hackberry, *Celtis occidentalis*, rivals White Elm; Oct.
 Kentucky Coffee Tree, *Gymnocladus Canadenses*, for southern Minn.; September.
 Boleana Poplar, Van Gert's Golden, Wobski, Siberian pyramidalis; cuttings.
 Wild Black Cherry, *Prunus serotina*, always pretty; Sept.
 Eu. Mt. Ash, Am. Mt. A.; Weeping Mt. A.; conspicuous; Oct.
 White, Bur, Red and Scarlet oaks from acorns; Autumn.
 Russian Golden Willow, Wis. Weeping, Laurel Leaved, Royal, Napoleon's; cuttings.
 Basswood, *Tilia Am.*, June fl's., honey tree; Oct.
 Camperdown Weeping Elm, protect; Rock, White E.; June.
 White Pine, White Spruce, Col. Blue S., Red Cedar, Savin Juniper, Arbor Vitæ (also Pyramidal and Golden varieties of) Balsam Fir, Norway and Douglas Spruces; these Evergreens are hardy, beautiful, healthy.

FLOWERING SHRUBS RECOMMENDED.

For the list of hardy shrubs, tested in our climate, the author specially is indebted to Prof S. B. Green, of the Experiment Station, St. Anthony Park; Jewell Nursery, Lake City; Prof. Robert M. Gray, manager of the Men-denhall's greenhouses, Minneapolis.

We should take into our calculation the value of windbreaks for our floral as well as other plants. Where they are exposed on the treeless prairies, some of them will not do well; must have proper screens against hot, bright suns and drying winds; also suitable protection will be necessary in the winter.

The season of flowering is mentioned so that the selection may be choice

with a view to continuous bloom in successive order from early spring till fall, and for the extension of their attractiveness even into the winter, so grouped in artistic arrangement as to form, size and balance, that the subordinated colors of the barks and the extreme contrasts of the evergreens with the mantling snows, may present a perspective beautiful as that of summer. Let us surround our homes with these "floral apostles."

SPRING FLOWERING.

June Berry, *Amelanchier Canadensis*; white flowers; edible fruit; April, May.

Missouri Currant, *Ribes aureum*, bright yellow; April, May.

Berberry, *Berberis vulgaris*, (purple leaved); yellow; June.

Red Branched Dogwood, *Cornus Sanguinea*, white; red bark; purple berries.

Weigela, *Diervilla rosea*, rose, trumpet shaped; May, June.

Bush Honeysuckle, *Lonicera tartarica*, pink, red, white; April, May, June.

Siberian Pea Tree, *Caragana arborescens*, yellow; early spring.

Buckthorn, *Rhamnus catharticus*, hedge plant, white; black berries; June.

Privet, *Ligustrum*, from Poland, white; May, June.

Nine Bark, *Physocarpus opulifolia*, var *aurea*, white clusters; June.

Meadow Sweet, *Spiraea Van Houttii*, white clusters; June.

Ash Leaved Spirea, *S. sorbifolia*, white, July; *S. obovata*, white; May.

Red Berried Elder, *Sambucus racemosa*, white; Golden E.; May.

Buffalo Berry, *Shepherdia argentea*; early flowering; silvery leaves; edible fruit.

Burning Bush, *Euonymus atropurpureus*, purple; crimson fruit; June.

Syringa or Mock Orange, *Philadelphus coronarius*, white, May; *grandiflora*, June.

Lilac, *Syringa Vulgaris*, purple-white; also Persian and Josika.

Smooth Leaved Sumac, *Rhus glabra*, greenish-red; also Cut Leaved; June.

High Bush Cranberry, *Viburnum opulus*, white; acid, red fruit; June.

Snowball, *V. sterilis*, white; also Arrow Wood and Sheep Berry; June.

SUMMER FLOWERING.

Snow or Wolf Berry, *Symphoricarpos*, white; fr't remains in winter.

Spirea *Blumaldi*, rose; July and August.

Rose Mallow, *Hibiscus militaris*, whitish, showy; late summer

Hydrangea, *H. paniculata gradiflora*, white; August, September.

Trumpet Honeysuckle, *Lonicera sempervirens*, red-yellow; May to Oct.

St. John's Wort, *Hypericum aureum*, yellow flowers in August, Sept.

Witch Hazel, *Hamamelis Virginiana*, yellow blossoms; autumn and winter.

Japanese Rose, *Rosa rugosa*, pink, white, flowers all summer.

The many hybrid roses cannot be enumerated here. For the lawn select only such as have been acclimated out of doors.

ORNAMENTAL VINES RECOMMENDED.

American Ivy, *Ampelopsis quinquefolia*, crimson in fall; July fl's.

Bitter-Sweet, *Celastrus scandens*, scarlet seeds in winter; July.

Virgin's Bower, *Clematis Virginiana*, white; *C. Viticella*, purple; all summer.

Moonseed, *Minispermum Canadense*, white; needs shade; July.

Frost Grape, *Vitis condifolia*, dark purple; hides deformities.

LAWN ORNAMENTATION.

Perspective arrangement for health and beauty is the all-important consideration. Close planting on the lawn is neither healthful, desirable nor practical. If so treated, the trees largely become bare of attractive foliage. They are far prettier if standing out single, their branches allowed to come out close to the ground, as if trying to hug it by their graceful curves.

Fast growing evergreens, such as the Scotch, Austrian and White pines should not be less than thirty feet apart. The slower growing sorts, such as the Siberian Golden, and Pyramidal Arbor Vitæ, and dwarf Mugho pine may be planted nearer. A few choice ones on the lawn, selected from the preceding list, suits the artistic eye; and they should have no set style about them, neither in position nor form. "Unity in diversity" is nature's method for perfectibility.

Fast growing evergreens lose their beauty generally as they age. Better put these in the back ground, hiding the deformities of the out-buildings.

One or two dwarf willows of high colored barks, a soft maple, a hard maple, a cut-leaved birch, a mountain ash—such as these can be sprinkled about the home lot in front, leaving ample spaces for flowering plants in cosy niches along the winding paths and edges of the grassy plats; the whole so naturally and tastefully arranged, that every view from the windows and from all angles shall present a new and engaging scene.

EVERGREEN SCREENS.

To separate the garden from the lawn, lane or other spot, and to improve the beauty of the premises, build up some screens or hedges with hemlock spruce, arbor vitæ or red cedar. Any of these species is pretty and durable.

PLANT FOR LONGEVITY.

In planting a windbreak or forest group, why not calculate for longevity? Fast growing trees, like some human beings, mature early and die early. The poplars, locusts and soft maples start off as if they were the "fittest," making rapid progress for about ten years, but soon lessen in rate, reaching their maximum before some other trees have fairly got a foothold. You may plant a field of box elders and by its side a field of ashes; the first will

shoot ahead and spread themselves with promise of leadership. Meanwhile the ashes seem to falter; but, understand, they are sending down tap roots, and at the end of five or six years, may be towering above their neighbors, and will survive when the box elders are gone. The oak, the beech, the pine, the spruce, the sugar maple, and nearly all shade-enduring trees grow slow at first, but when the light-needing species have about reached their maximum, the former have just fairly begun the race for longevity, some of them demarking the centuries. In a few years our pioneer trees, so useful in their time, will largely have to give place to the slowergrowing and hardier sort.

SUCCESSION OF TREE GROWTH.

Almost universally the notion prevails, that "when the pines are gone they are gone forever, and that the soil where they grew is worn-out, unfit to reproduce good timber qualities." This notion, so damaging to forest preservation, also discourages improved forestry on the prairie where temporary trees are often planted only for the present convenience of the proprietor.

Alternations of trees are as various as the species within the territory where they occur. In the southern states especially, and sometimes in the northern, oaks take the place of the departing pines, and so the reverse. But the succeeding oaks stand no show compared with the poplars, aspens especially, and the canoe birches. The latter grow on moist or dry places; fires cannot eradicate them. Both wait on wings of down their millions upon millions of almost infinitesimal seeds that alight everywhere. Burnt districts or any cleared lands are their paradise. Hence, all along the northern tier of lumber states, and over the Canadas, even to the Arctic Circle, these trees take possession of the denuded lands. Fortunately they are short lived and often pave the way for the return of the pines. Oaks get a foothold, too, interspersed with other hard woods, for their seeds and roots, long buried under the leaves and soil get sunlight enough to sprout. These facts demonstrate that with proper management we can have the most valuable trees, only plant and preserve them, and keep out fires and browsing stock.

So far from the forests having a worn out soil, it is the best in the world. The decay of the fallen leaves and limbs, the carbon dioxide thus evolved for plant growth again, the nitrifying agencies of the net-work of roots, form the rich humus of the future farms. Neutralize this fertilizing art of nature by injudicious cutting, or burning the leaf mold, and not only is the soil thus impoverished and drouths provoked, but sorrowful alternations of trees inevitably ensue. H. B. Ayres, a forest expert in our state and close observer, avers that burnt land "could not be put in condition as promising (as an adjoining unburnt tract) for less than \$20 an acre." On an unburnt acre cut the same winter—three years before his investigations—he counted "1267

little white pine seedlings, two years old," growing under the shade of immature pine saplings, poplar, maple and hazel brush. Every woodsman has noticed like results wherever fires in the pine regions are excluded. The English oaks grow today in places where William the Conqueror found them when he invaded Britain. For centuries the pines of Maine have repeated themselves on their native heath. Given the conditions, and the "fittest" remain while human generations come and go.

RATE OF WOOD MAKING.

Trees begin to make wood faster when they have fully developed their crowns. But in the hurry for profit men seldom wait for that. "The growth in volume or mass accretion," says Prof. Fernow, "is quite small in young trees, so that when wood is cut young, the smallest amount of crop per year is harvested, while, if it is allowed to grow, an increase more than proportionate to the number of years may be obtained."

PLANTS OR SEEDS—WHICH?

Germinating seeds on the open prairie is attended with more or less uncertainty, depending largely on the season; if they do germinate they are subject to our terrible drying and freezing winds, rendering their lives precarious the first and second years. Besides, too many seeds come up in the hill where a single tree only is wanted, and the surplus has to be plucked out at extra expense. All things considered it is better to put the seeds in a properly protected seed bed, and then the "fittest" can be selected.

SEEDLINGS ARE GENERALLY THE BEST.

In a healthy state the roots of a seedling are as naturally adjusted to its stem as the limbs. A cutting has to spread its roots out more horizontal than a seedling, and does not, as a rule, make so reliable a tree. Nor is a sprout equal in value to a seedling. It may grow rapidly at first, but soon slackens its rate and seldom, if ever, attains the height and diameter of a seedling.

RAISING TREES FROM BROADCAST SOWING.

Note how nature plants her trees and copy as near as possible. Some farmers on our western prairies have raised the finest forest groups by sowing mixed fall seeds broadcast on the deeply plowed and finely pulverized soil, harrowing them in. Of course they sprout up thick in the spring, thus largely mastering the weeds, but where the weeds get ahead, they are pulled up by hand, and all grasses kept out by the hoe. This is a slower method of raising trees, but cheaper in the long run; and such trees will thin themselves out, and become forest like, and the very best of wind-breaks.

TREES PER ACRE.

The following number of trees per acre are required when planting at the distance here indicated:

6 by 6 inches	154,240	2 by 4 feet	5,445
12 by 12 inches	43,560	3 by 2 feet	7,260
18 by 18 inches	19,360	3 by 3 feet	4,840
2 by 1 foot	21,780	3 by 4 feet	3,630
2 by 2 feet	10,890	4 by 4 feet	2,722

MUTUAL SUPPORT.

Begin, then, densely for safety and mutual protection; thin out as necessary. Mix the trees. Have, say, five or six hundred per acre, light-needing substantial oaks, pines (white leading) spruces, elms, hickories, ashes, black walnuts, sugar maples, black cherries, placed at proper distances. In time these will hold sole possession. Succor these by pioneer trees, such as the box elders, the white willows, the soft maples, the butternuts, the bass woods, the poplars.

CULL THE BEST OR POOREST—WHICH?

When your trees have grown large enough for fuel, building purposes, or fencing, will you follow the example of lumbering men, cull the best and leave the poorest? Will you thus make a truce of peace with the weeds and grasses, the winds and fires? It is the popular way, but it ruins your wind-break or forest. If you plant only for yourself, indifferent to the needs of your successors, with no love or pride for the beauty of the state, it is to be expected that when you are about to rot down, as you providentially deserve, your trees will perish with you, and the cyclone will howl a fitting requiem over your treeless, nameless grave.

HOW TO PERPETUATE THE FOREST OR WINDBREAK.

It costs too much and the woodland lot is too precious as a protection and source of profit for fuel or lumber, to let it run out for want of proper care and attention. In the older settled portions of southern and central Minnesota, tree plantations have in places grown to such size as to necessitate special treatment for their perpetuity and use in constant improvements.

The first principles of preservation must be considered. As already hinted, the object to be sought is the self-sustaining capacity of the forested soil. Remember it is the crown cover, the woody underbrush and the heavy layer of well-decomposed humus, that intercept the effects of hot drying winds and the compacting force of beating rains, which in the woods reach the ground gradually with only gentle friction, thus keeping the soil loose and granular, enabling the water to penetrate rapidly and make its capillary movements among the roots with perfect facility.

EXCLUDING GRASSES AND WEEDS.

To secure the object just mentioned, the crown cover of a windbreak or grove should be uninterrupted in the main. This is accomplished by close planting of light-needing with shade-enduring trees. If permanent openings are allowed, the grasses and weeds are sure to get in, binding the roots to the injury of the plantation. Grass especially, transpires far more water than woody plants, thus monopolizing and deteriorating the soil. Whoever aims to preserve the life and use of his tree plantation will watch with prudent care that the shading is so managed as to exclude the root-bind of grasses and other injurious intruders.

UTILIZING A CROP OF TREES.

What is wanted is to utilize such trees as are old enough with a view to their reproduction. In agriculture the yearly crop is fully removed and a new one planted for succession or rotation; but this cannot be done with wood crops, for it takes a series of years, sometimes a century or more, to develop them to maturity. True, the proprietor can clear a forest for utility, and plant there the same or other species of seedlings, but this interrupts timely seasons of profit where forestal areas are very limited, as on the prairie, and lands are considered more profitable for agriculture when immediate profit is the object.

THINNING OUT.

Inspecting the results of the common methods of thinning, one would think the very devil had been at work to see how rapidly he could destroy them. Usually no thought is bestowed upon the laws of sylvan society. By virtue of close companionship where cuttings have not obtained nor fires raged, the trees of Minnesota are certainly acclimated to the conditions of trees scattered in the open of southern Michigan.

To cut and slash as farmers and lumbermen do, thoughtless of consequences upon the remaining trees, to say nothing of climatic sequences for the worse, is as cruel to the trees as to turn a group of tender children out into the winter cold without providing proper clothing for temperamental change. Such farmers may have good intentions, for they want some large trees for agricultural shelter and future fuel, if not for lumber, but this worthy purpose does not prevent nature's just chastisements. The limbs of the larger trees break down, the trunks bend and shiver, rot gets into the heart, speedy death follows, and the young trees, if they escape the fire, "live at a poor dying rate."

GRADUAL THINNING.

It needs but a moment's reflection to know that the thinning must be gradual or failure ensues. Prof. Fernow thinks that the first necessity for thinning may not arise with the light-needing species earlier than the twelfth or fifteenth year. "It is better to thin carefully," he says, "and re-

peat the operation oftener than to open up so severely at once as to jeopardize the soil conditions. Especially in younger growths and on poorer soil, it is best never to open a continuous crown cover so that it could not close up again in five or six years." When trees attain 50 or 60 feet, the thinning may be more severe, practiced only every six to ten years. Soon as the crowns touch and interlace, thin again. "In mixed growth it must not be overlooked that light-needing species must be especially protected against shadier neighbors. Shade-enduring trees, such as the spruces, beeches, sugar maples, and hickories bear over topping for a time and will then grow vigorously when more light is given, while light-needing species, like the pines, larch, oaks and ash, when once suppressed, may never be able to recover."

SAVE THE SUPERIORS.

As we have seen, the object of the nurse trees is to aid in the development of the "fittest." This attained, their use may have ended. If they over-top the superior, "out of my sunshine" is the order, or at least top down and give room for the better. As "side shows," aiding in further development of the superior shaft-trunks, they may be retained, but when they have cleared these trunks of needless limbs by shading, the time for their removal has come; but it should be done with great care lest thereby the soil be exposed too much to the sun, drying it up and retarding wood accretion. Fast as the inferiors crowd upon the superiors injuriously, then remove the former judiciously so as to preserve the continuity of the needed shade.

IMPROVEMENT CUTTINGS.

As here shown, thinning should be for improvement, and cutting for profit should be to accomplish the same ends. In this respect we cannot yet apply the European methods, however meritorious they may be, where forestry is made a special science. We must accept our situation as it is and make of it all it is worth, moving forward by evolutionary steps. We do not ask for an abandonment of cutting for profit, but do ask for forest improvement in the operation. To cut mature trees, or what can be profitably utilized without an eye to the healthful perpetuity of the plantation, leaving the balance of the trees to fall into ruins and be at last cleared by the inevitable fire, followed by deteriorated soils, is, to say the best, a vandalism too vandalish to tolerate in our age of economic civilization.

CUTTING TO GROW AGAIN.

If in thinning out or other purposes, you wish to have your trees sprout again, preserving the species and forest continuity, cut on a level with the ground just before the sap starts, such trees, not over twelve or fifteen years old, as the ashes, bur and jack oaks, box elders, basswoods, willows, cottonwoods and other poplars. Old trees, remember, lose their power of re-

production both in seeds and sprouts. Do not wound or tear off the bark, for the sprouts come from its inner layers. Use an adze and leave the stumps convex, so that the rain will not gather in the heart, producing rot. Cut away such sprouts as are not wanted.

TO PREVENT SPROUTS.

If the object is to destroy shoots or sprouts, cut in summer, July or August, when the leaves are in full maturity.

CUTTING FOR DURABLE TIMBER.

Railroad ties, fence posts and the like should be cut in the dormant season, the winter, as you would mature trees for lumber. Hoop-poles should never be cut when the bark will peel.

POLLARDS.

Where it is the design to obtain more and lower slightly shade, the tops of quite large poplars, willows and sometimes soft maples are cut off entirely. Such trees are called "pollards." Men, ignorant of the laws of tree growth, often cut below the division of the first branches; then the young shoots can only form around the margin of the headless trunk, and the middle part of such section usually becomes rotten. If the amputation is higher up, cutting off the lower and entire first branches, the tree will tend to make a graceful head, and the trunk will remain sound.

PLANTING EVERGREENS IN OAK OPENINGS.

A correspondent asks as to planting evergreens in sandy loam among the bur or jack oak openings. Experience, of course, settles the question. It is certain where trees (applicable alike to apple trees and other fruit plants) are taken from the rich soil of the nursery, and transplanted into a sandy or any depleted soil, or soil that is non-adaptable, they have a severe struggle at first to get a foothold; scarcely grow at all for a year or more, and are quite liable to fritter out and die.

GREEDY FELLOWS.

The oaks are greedy fellows; what nutrition they can make or obtain, they are sure to monopolize; and there may be little or none left for new occupants. Their shade is favorable for evergreens, provided it is not too dense. Sunlight, they too, must have, which if sifted by a thin curtain of oak leaves, will help them to surmount the difficulties of their environment.

CART IN FERTILIZERS.

First subdue that wild soil by cultivation, or make very large holes for the trees, so as to loosen up the soil for proper air circulation. To start the trees healthfully, better cart in some rich dirt for the roots; or mix some rotten manure or decayed leaves with the crude soil. Water the roots in, an abundance of it at first. Mulch at far distances from the trunks. You will

no doubt then succeed. The Scotch and white pines, and native white spruce—these will be adaptable selections.

PLANTING TREES IN CLAY BEDS.

Another correspondent asks advice relative to the safety of planting large trees, in cold, clay beds. Doubtful if any of our desirable trees can survive in a loam composed of nothing but clay. Better dig out monstrous holes, cast in some rich, cultivated soil, properly compacted among the roots. Whatever portion of the clay is used, should be mixed with sand to render it friable, so that it will rest lightly over the base of the tree. There is danger lest water will form a pool there, being walled round by the impervious clay, which may kill the tree. Hence drainage should be provided.

PLANTING ON SANDY PLACES.

The rules herein laid down for preparation and culture of soil are not applicable to sand-drifting localities. The least stirring of such ground may be the wiser course to pursue. No use to stick in cuttings unless the season is unusually wet; nor is it practical to try forest seeds in so desert conditions. Rooted plants only will do. As it is unsafe to cultivate there, better plant the small size trees promiscuously and densely for mutual protection and early shade. The pines are less evaporative than the deciduous trees, hence will better stand the test. Put the roots down deeper than ordinary to be as much in touch with moisture as possible. Try the Scotch, bull, jack, red and white pines, arbor vitæ, red cedar, our native white spruce, the white and green ash. For root shade try the wild prairie rose, the sand cherry, the choke cherry, the buffalo berry, the dwarf gray willow (*Salix tristis*), the native dewberry, and some of our sand and soil-binding grasses, having strong creeping rootstocks, such as long leafed sand grass (*Calamovilfa longifolia*), and Redfield's grass (*Redfieldia flexuosa*), both common in the more sandy regions of our West.

SAND DUNES.

Where the sand is liable to drift before strong winds, it may be necessary to employ the methods used upon the sand dunes of Holland, Denmark and France, upon Cape Cod, Mass., portions of Florida, and other parts of our country where deforestation has provoked sand drifting to the ruin of all vegetation in their wake.

HOW TO HOLD THE SANDS.

Palings of boards are driven down endwise about an inch apart, so that the sand, gliding along the surface, piles up in front of the paling, and, passing through, is deposited behind. As the dune rises higher the boards are pulled up a few feet more, and thus the process goes on till a sloping hill is formed, over whose barriers the wind has to climb, hollowing out the sand somewhat, but is practically broken as it strikes down on the opposite

side. The better to produce stable steepness, woven brush is also piled on the top from time to time. Then grasses and other plants are made to grow on the front slope. Then trees are planted there in conquest over sand and wind, and the once "desert place" becomes a beauty and a profit.

WILLOWS FOR RIVER EMBANKMENTS.

Owing to the spring floods, floating ice and swash and plunge of logs and boats, great inroads are made upon the banks of our large rivers, sometimes undermining buildings, creating sand bars, wasting the soil and doing other damage in the angry rush. Nothing can so well prevent such disasters as to plant willows wherever the danger lies. Let them dip their roots close down to the water edges. White or gray or black, almost any kind of willows, will answer the purpose. Though the spring ice may break down their tops and pile debris upon them, yet their tenacious and entangled roots will send up new shoots thicker than ever before, and at length will become so solid a mass as to arrest sediment in the little eddies among their meshes, purifying the water, building up the banks and adding to the healthful rapidity of the river.

REEDS FOR BINDING THE BANKS.

The common reeds (*Phragmites*) are regarded among the most valuable grasses for binding the banks of rivers. The rootstocks are so strong scarcely anything can move them. The young shoots are liked by cattle; the mature stems make the best thatch.

PLANTING IN WET AND BOGGY PLACES.

Where it is not desirable to ditch a wet place, such as a bog or swamp, or low slough of the prairie, dig no holes, for that would surely kill the trees; but spread the roots (tapless) on the surface and build on them suitable mounds of sods, mosses, sticks and stones to hold them secure. Select trees, spruces, pines, yellow and white birches, willows, larches, ashes, that are from 5 to 6 feet high. Set them out irregularly and forest-like. The success will be wonderful. In this way the fire-swept marshes of the state can be speedily regenerated. The rapid wood accretion and very copious evaporation will drain out the surplus water. Would not this method of drainage be the most economic one for the state to invest in? Could a more practical use be made of our now desolate marshes?

PLANTING TREES ALONG HIGHWAYS.

Wherever trees are planted, the object sought should determine the species, distances apart, sizes, etc. Where they stand thick and hedge-like along the highways, they are apt to trap snow and pile it in high drifts, and in the spring hinder the roads from drying so rapidly, also during summer rains, as in the open country. Nor is it desirable to have so many there as to hide plain views of the country. It is therefore recommended, that trees for the roadsides be placed 50 to 60 feet apart, and gradually pruned

upward so that they shall tower high, thus staying hard winds, and afford ample ventilation and perspective.

The soil will need to be managed as described, plowed deep and kept cultivated until the trees are strong and large enough to take care of themselves. The ashes, elms, basswoods, hard maples, of quite large sizes when planted, are good sorts for the highways of Minnesota.

PLANTING ON STEEP PLACES.

Along some of our river and lake shores are areas of rocky and clayey bluffs, many of them so barren as to be worthless even for pasturage. Were they clothed with forests, it would greatly conserve evaporation and become otherwise profitable and picturesque. Than such, harder places have been regenerated in the old world. Ploughing them would be no advantage, but add greatly to the waste under pelting rains and the slush of snows in the spring. As recommended by Prof. F. B. Hough, Elements of Forestry, page 57; dig "horizontal terraces or notches at convenient intervals, securing their outer edges with brush held in place with pegs. In a year or two these notches will have probably become filled up by the crumbling away of the rock above, and in the soil thus formed, trees may be planted with a prospect of success."

Begin with our native white and green ash, and bur Oaks (planting the acorns) and shade the candidates with our hardiest shrubs, mentioned in this treatise, not forgetting how efficient in this respect is our native prairie rose, whose tap-root will find moisture if it has to go down five or six feet to reach it. Better mix some well rotted manure with the sterile soil and then mulch the entire terraces not less than six inches.

LAYERING.

Lay down a branch or stool shoot, cut a slight slit where you would have it sprout, and bury it in the soil, leaving the top out, and it will develop roots, when it can be severed from the mother tree for a plant of independent life. Choice sorts are thus easily propagated.

ROOT SUCKERS.

If you wish to multiply special trees, hurt or cut some of the roots, loosen the soil around them and manure well. The suckering takes more readily with old trees, and in the spring, when they can be soon removed to the new plantation. But such trees seldom become beautiful or equal in all respects to the original; besides such have a strong tendency to root sucker.

HEDGES.

Hedges are living fences and screens. Much inquiry obtains as to what is hardy and most serviceable. Col. John H. Stevens recommends the buffalo haw, *Shepherdia argentea*, being thorny, tough and pretty; effectually resists cattle. The honey locust is used in Iowa and some other southerly states, but it is very liable to be destroyed by borers; not so in the

buffalo berry. Both these plants would have to be annually cut back in broad-base pyramidal form, and when the dwarf habit is fully established, the hedge may need but little care. The scarlet thorn, a native of the cold regions, will thrive in our soils. The prickly ash, *Zanthoxylum Americanum*, is certainly valuable for the purpose, with the exception that it propagates readily from the roots. It is very common, and the branches are armed with strong conical, brown prickles with a broad base. Where the exclusion of stock is not the object, no hardier or prettier hedge can be planted than the hemlock, *Abies Canadensis*, or the American arbor vitae, (white cedar). Prof. W. W. Pendergast, Sup't. of Public Instruction, well posted in plant experimentation, recommends the buckthorn, *Rhamnus Catharticus*, that has proved very hardy in Minnesota. His treatment of the seeds and seedlings will apply to the buffalo berry and other hedge plants, including the barberry which is highly recommended.

"Soon as the frost is out of the ground in the spring to the depth of three or four inches, mix a pound of buckthorn seed with about two quarts of finely pulverized sandy soil, and having rubbed it well with the hands in a pail of water to separate the three seeds which grow in each pocket, place the mixture in a box six inches square and six inches deep, in the bottom of which several holes have been previously bored for drainage, and cover the whole with half an inch of fine soil. Sink the box in loose soil in some sunny spot, and occasionally sprinkle with soft water slightly warmed. Be careful not to water too frequently or too abundantly, as in such case the seed will rot. If the season be rainy, it will not need watering at all. The ground should be kept somewhat moist, but not wet. About the first of May begin to examine the seed to see if it has sprouted. When the little white roots begin to protrude from the seeds, make a garden bed about a rod square and sow the seeds half an inch deep, making fourteen rows, and sowing about four hundred seeds to a row. The plants should grow two years in the bed before being set in the hedge-row. Cut back to half their length and set in parallel rows one foot apart, and plant one foot apart in the row, breaking joints so that each shall be opposite the midway point between the nearest two in the other row. Prune severely for the first few years, so as to make the hedge thicken up well at the bottom. A pound of seed should make 180 rods of hedge."

PRUNING TREES.

As a rule, June and the first part of July are considered the safest months for pruning; for then the trees are in full tide of life, and the leaves have about reached their mature size. Very many of our farmers prune in March or April, because they have a little leisure then. This is decidedly the most dangerous season of the year. If the pruning is done to the trees that have been standing for years and are in full vigor, the abundance of sap in the little tubes that feed the limbs, may stagnate and ferment at the cuts, causing rot, especially if the limbs are large. The flow of sap is not so copious in trees to be transplanted, especially with such as have lain dormant all

winter, heeled-in; for they have not yet got sufficient hold in the soil to produce vigorous transpiration; hence, such may be pruned to balance their roots at any time of replanting. It will do to prune small limbs of standing trees in June, but not large ones, for their wounds are too broad and old for nature to heal over that season, and may never be able to do it, besides they are very liable then to rot at the cuts.

MENACING TO TREE LIFE.

If necessary to cut off large limbs, do it in September, or October, or some frostless days in midwinter, when there is greater freedom from flowing sap, and when the cooler weather may allow the wounds to season. Large limbs correspond with large roots. If you cut off the former you endanger the life of the latter, and invite a rotting process to roots which in turn convey the decay to the leaves and thence to the trunk. Like a gangrene in a flesh wound, poisoning the blood, it infuses disease into the sap. A badly pruned tree, especially if mature, soon becomes hollow and succumbs to a rotting death.

DANGER OF PRUNING EVERGREENS.

Some men think they must prune all their trees, because it is the style. This is done on the principle that it improves a horse to cut off his tail. They assume that nature is "totally depraved" and never can right herself without their intervention.

If you want them for timber, plant them dense, and they will spire up tall and timber-like, and will prune themselves better than do nine-tenths of the intermeddlers. But for windbreaks and ornamentation, don't touch a limb after the tree has stood a year or more, unless a little cut here and there of the fine saw or sharp knife is necessary to the perfection of the tree. If you plant young evergreens, nursery grown, that have been two or three times transplanted, thus developing an extra amount of root hairs, they will balance themselves with limbs trailing low down to the ground and towering up in graceful beauty. A few rules for all kinds of trees:

Where two limbs cross or rub against each other, cut one off.

Remove the sprouts from the trunk and main branches, unless new branches will improve the tree.

Cut off all dead branches at any time.

Thin the head and let in sunlight, if it be too dense and shady.

Always cut close to the bark.

Pruning a tree weakens it; hence be guarded. The amount of wood growth "depends upon the extent to which the nutritious elements of the soil and air are elaborated and prepared by the leaves, and in reducing their amount by trimming, to that extent do we lessen the productive forces of the tree, and for the time being reduce the amount of the annual gain for the next and succeeding years, until a proper balance is secured by a new supply of leaves."

EXUDITION OF EVERGREENS.

Says Carriere, a French forester: "The evergreens differ in their ability to bear pruning according to the abundance of resin that they contain, and in some of the pines wounds will bleed a long time after the injury." To the question, "Should we prune the resinous conifers?" Carriere answers: "No, if kept for ornament, whether alone or in masses, because in their native condition they are most agreeable to the eye; but yes, if the value of timber is the object."

Says Prof. Hough, another good authority: "The most important objection raised against the trimming of evergreens is their tendency to the exudition of resinous matters, which in the Scotch fir and larch will sometimes destroy the tree altogether. The exuditions may go on slowly, and seem to be stopped from time to time, according to the season of the year and the activity of the vital process, but it reappears with warm weather, and will resist any application that may be made to prevent it."

DISBUDDING.

There is little or no danger to our evergreens, or any other tree, if we simply rub off with the hand, when the tree is young, what buds we do not want, and thus prevent undesirable limb-forming. This is the true artistic way of pruning. By so doing the practical forester will have symmetrical trunks and balanced foliage to order. If this method were employed in the timber plantation, the trees—other conditions equal—would be free from knots and conchs. How important that we attend to these things in season! When we attempt to aid nature, it is wise to know what we are about and how to do the proper thing.

TREE SURGERY.

If live, large limbs must come off, do the work intelligently with the care that the skilful dentist uses in improving the teeth. You would not employ an ignoramus to doctor even your cow; why should you put such a fellow into your beautiful grove to prune your trees? Ten chances to one he will irreparably impair the value and life; too, of every tree he touches. In our West where shade is so much needed, precious little pruning should be done, as a rule, and then only to aid nature for better shade and better light. Only necessity should govern the action of pruning.

BARK WOUNDS.

It is well known that if two-thirds of the human skin is burned or scalded the person dies. It is so with a tree. The bark is the skin. On its continuity and healthfulness depends the life of the tree. Its vascular system called the *lactiferous tissue*, exists in the form of a complete net-work of vessels, through which the sap circulates in all directions. If the inner coatings just under the epidermis, called the *cellular integument* and *liber*, are removed, exposing the glutinous matter, or *cambium*, deposited by the sap for woody structure, the circulation is interrupted proportional to the

size of the wound; if half or more of the bark is ripped off, half the sap-life is stopped, and unless early and properly doctored the tree will be very likely to die. Sometimes the rabbits will gnaw it off clear round, and then not a particle of sap can pass to or from the leaves or roots.

TREATING A FRESH WOUND.

If the wound is a fresh one, and the cambium has not yet dried out, there is a chance to save the tree, despite the rabbit's teeth. Sometimes burying the entire trunk with moist soil may save the tree, for then the cellular tissues, thus kept damp and protected from the drying air, will begin to heal, knitting their fibers together for new bark. Plastering the wound with grafting wax, or cow manure, answers the better purpose.

GRAFTING OVER DEAD WOUNDS.

If the cambium is literally dead, and life yet remains in the upper bark, procure some one year limbs or suckers of the same species; cut the ends as you would for grafting or budding, and insert both the top and lower ends under the ungnawed, healthy barks; band such attachments with waxed cloth; have all the barkless space thus completely covered; and the tree may recover its former vigor, by virtue of the life-connecting links.

TRUNK CAVITIES.

On our lawns and street sides are many trees injured by neglect or bad pruning, too valuable to lose, which, if timely cared for, can be made about as "good as new." As before shown, dead limbs left on too long, or large live limbs bunglingly amputated, invite the soaking-in of rain and the lodgement of insects, causing premature decay. We cannot too strongly emphasize the remedies prescribed at the close of the article on "Forestry in our Schools." As therein stated, the cutting away of all the loose, injured bark must be deftly done. In preparing conditions for nature to heal a flesh breach, the skilled surgeon slightly irritates the edges so as to produce an exudation of healing element; so with a tree, the cut must penetrate into the live, healthy bark, smooth in regular outline, especially on the lower side of the cavity. The seasoned piece of oak driven into the hole must be made to plug up every chink, and be smooth and on a level with the inner, live bark. The metal piece, nailed on to protect the oak piece from rotting must be so fixed that the healing lips of the bark can readily close over it. The coal tar then put on covers the whole, excluding all further danger from moisture.

VIRTUE OF COAL TAR.

"Coal tar has remarkably preservative properties, and may be used with equal advantage on living and dead wood. A single application produces a sort of instantaneous cauterization, and preserves from decay, wounds caused either by pruning or accident."

TREE BLISTER.

When trees are found to "blister," or liable to, when exposed to the direct rays of the sun, shade them with boards or screens of some sort. By planting closely, little or no injury occurs from the blistering, if, indeed, it occurs at all, because a dense shade shelters the trunks of the trees. Horticulturists take advantage of shade for their apple trees by planting them on an angle dipping to the southwest, so that the trunks may be under shadow from the direct action of the sun.

HOW TO SAVE PERISHING TREES.

It is a noticeable fact that leaves begin to fall sometime in the growing season, or when it should be the growing, as in the latter part of July or in August. The vital circulation in a severe drouth, being then suspended or checked, the leaves die and drop off as naturally as fruit drops off when fully ripe. It would seem that whatever arrests the circulation or transpiration, whether heat or cold, produces the same result. Thermal conditions, however, may be considered as secondary causes. Reduce the foliage, dig around the tree out from the trunk, harmless to the roots, and let in air and water; keep the tree covered with wet rags or wet straw for a week or more.

CREVICES IN TREES.

Some trees have crevices in their trunks, produced by wind, frost or other agencies, probably bleeding to death. Cut out the dead matter down to the live wood, and apply coal-tar, or, with a rag, bind on—not too tight—cow manure.

ROTTEN SINUSES.

Where a dead branch is left on a tree, more especially if large, water soaks in and follows down the fibres, causing a rotten burrow, sometimes extending a long distance down the trunk, resulting in a hollow tree, as commonly occurs with old basswoods and some other large timber. The infirmities of age applies to trees as to mortals. When trees have reached such conditions, there is no remedy but to cut them down. An alarming per cent of our native, and soon, if not already, of our planted trees, is rotting to the heart because of dead limbs left on, and other agencies, which it is in our power to forestall, if we will only be vigilant in our care for them.

DRY ROT.

Where trees are in very warm, close and moist places, they are apt to be infected with the dry rot. It is caused by the development of a fungus, and can be detected by a brownish-white mold covering the wood, which sends its fibres into the tissues. "This vegetable first appears as delicate white filaments, interlacing with one another, attacking the wood fibre, and changing the ligneous mass into a loose cellular tissue, that readily falls into powder. The surface may remain sound when it is but rottenness within. It does not appear in the growing tree, and appears to be favored and

developed by a fermentation of the juices." When there is a tendency to dry rot, it can be checked by using carbolic acid and other pyroligneous products. Perfect ventilation is an excellent means of prevention.

BARK BOUND TREES.

Where the bark is very hard it hinders expansion, and the tree languishes. In the spring when the sap is starting, with the point of the sharp knife make an incision down the north side of the tree. The accretion of the trunk is rapid and the health of the tree improved as shown by the strip of new bark along the line of the incision.

RAPID DYING OF CITY TREES.

Owners of trees in the city lawns and along the streets, wonder why so large a percentage of them die every year. The cause is apparent. The smoke from the furnaces and chimneys send out noxious vapors that more or less injure vegetation near them. The short supply of water caused by drainage, the impervious pavements, concrete and hard-trodden streets and walks, prevent proper circulation for the roots. The leakage from the gas pipes is a deadening poison to every part of the trees. Remedy: Eliminate the "smoke nuisance;" give freer space around each tree; prune judiciously; soak the roots well during drouth; top-dress with fresh soil; close up the gas leakage.

SWINE ON THE PLANTATION.

A correspondent asks "if it is safe to pasture hogs in a tree plantation." Yes, if the trees have reached a certain stage of growth, say six inches in diameter, and it is done in the early part of growing season when their nose-rooting will loosen up the soil on the hunt for larvæ, whose extermination rescues the trees from insect ravages. If you wish to retain the young underbrush—generally useful—better not let the hogs in, for they will be very likely to nose them down and eat up their tender roots. When the oaks drop their acorns, let them enjoy a feast. If it be discovered, however, that they then begin to dig again, better deny them, for the stirring of the ground so in the fall, quickens the flow of sap, dangerous to tree life at that late season.

SHALL OTHER DOMESTIC ANIMALS BE ADMITTED?

No! It is inconsistent with the growth of young timber. They eat down the young shoots, and hasten their decay in the very roots by their ever-recurring tramp in the woods, that inevitably hardens the soil, and therefore prevents the percolation of water necessary to the life and health of the trees. The damage done by sheep and goats is greater than from horned cattle and horses. We have a law now for the prevention of forest fires, sufficient, when enforced in season, to meet such emergencies; but with fires excluded and domestic stock admitted, what prospect is there after all of rebuilding and perpetuating the forestry of Minnesota?

DEPREDATION OF RODENTS.

Of wild animals, the rodents are the greatest damage to our forest and fruit trees, especially mice, gophers and rabbits, gnawing the bark and eating off the roots. Any kind of paper tied around the base of the tree will keep the rascals at bay; so will wagon grease or blood brushed over the bark of the trunk; but the really effectual prevention is their extermination by poison or gun.

CUTTING BACK SEEDLINGS.

Where seedlings for replanting are seriously wilted or top-heavy, you can save them by cutting them back almost to the crown of their roots. If the roots have life in them—better soak awhile in water—and are planted rightly, they will sprout up strong and have symmetrical and rapid growth. Such treatment of over-topped cottonwoods and other trees, even when every way healthy, secures the better growth. Planting their roots, is recommended by nurserymen. Box elders, grown in the shade of woodlands, have kinky limbs, not so well balanced as those of the nursery where they have more light. After they are transplanted into the open prairie, the upper parts struggle along and finally die, but the next spring, up shoot strong beautiful blades and limbs. Had you planted only their roots, you would have saved time in their growing, and been surer of success.

GRAFTING—HOW TO MANAGE.

Grafting to improve the stock of trees is of late commanding the special attention of the friends of forestry. The following rules are applicable to fruit, as well as timber trees:

“The kind of grafting most likely to be practiced on the farm is that known as cleft-grafting. The process is a simple one. Saw off the limb to be grafted where it is an inch or less in diameter; trim the edges of the ‘stub,’ smooth and split it with a large knife or a cleaver made for the purpose. The cleft should not be more than four inches deep at the most. A wedge is now inserted in the centre of the cleft and a cion is set on each side of the cleft. The cions are made of twigs of last year’s growth. They should be cut before the trees show any signs of starting in the spring. When the cion is prepared ready for setting, it should contain about three buds. The lower end is cut wedge-shaped by slicing off each side of the cion. On one side of this wedge-shaped portion, midway between its top and bottom, should be left one of the buds. When the cion is set, this bud will be deep down in the side of the cleft in the stub, and will be covered with wax; but, being nearer the source of nourishment, it will be most apt of any buds to grow, and it will readily push through the wax. The cion is set into the cleft by exercising great care that the inner surface of the bark on the cion exactly matches with the inner bark on the stub. A line between the bark and wood may be observed. This line on the cion, in other words, should match the line on the stub. Wax the whole over carefully and thoroughly. Do not leave any crack exposed. Grafting wax is made

as follows: Melt together resin, beeswax and tallow in equal parts and spread on cotton cloth. Tear into strips and wrap around graft."

WATER RESERVE FOR PLANTS IN WINTER.

Experimentation proved that slight circulation obtains in plants when frozen; hence a proportional evaporation goes on. In a severely dry winter, trees and shrubs literally dry to death, the same as they do in a long continuous dry summer. It is found that, under such circumstances, when they are well watered in the late fall, and just before the freezing-up time, they will come out in the spring in quite healthy condition. If the roots and trunks are all right, but some of the limbs dried out and dead to all appearances, you will frequently notice in the spring-quickening, that the life-juices will creep up, capillary, in the struggle to revive them, sometimes forming late and feeble leaves. Under these conditions it is better for the tree to cut off such limbs. But this killing-down process can be largely prevented by watering as described.

RAISING CUTTINGS IN WATER.

Almost any plants with comparatively hard wood can be made to root by being placed in bottles of water. The oleander is a familiar illustration, The ivy also can be raised in this way. After the roots have become strong in the water the plants can be taken out and placed in earth. Meehan's Monthly says: "For this perhaps it is better to let the water continue stagnant in the bottles. A change of water is not beneficial. A saucer of sand, filled with water is all that is needed to root many soft wood cuttings. These saucers with the cuttings should be kept shaded for a day or two, and then placed in the full light. If placed at once in the full light they are liable to wilt."

WINDBREAKS IN HORTICULTURE.

It is an established fact that orchard trees planted in the proper relation to a windbreak, either natural or artificial, make a thriftier growth and stand more upright. J. S. Harris, a veteran horticulturist, giving his experience and observation, thus elaborates the practical benefits of the windbreak for orcharding:

ECONOMIZES THE SNOW.

"The windbreak of timber, to a certain extent, prevents the snows of winter from drifting or blowing away, and also saves the fallen foliage upon the ground where most needed, and at the same time prevents the soil from being so deeply frozen; consequently, there is less danger of injury to the roots. There being more snow on the ground to melt in the spring, the soil absorbs more moisture.

BUDS NOT WINTER KILLED.

"The buds of trees are less liable to be winter killed or injured in extreme weather, when properly sheltered, and the trees on the favorable side of a grove or belt will frequently blossom full when those upon the opposite side are killed.

SAVES THE BLOSSOMS.

"A windbreak upon the north and west side of the orchard and garden saves a crop of fruit by sheltering from northwest winds that often occur when trees and plants are in bloom, and from later colder snaps that often cause the greater part of the crop to blight and drop before half grown.

UNIFORM BEARING.

"Windbreaks very often save heavy-laden trees from being broken down or up-rooted, or the fruit grown being blown off in heavy wind storms. They tend to make orchards more uniform in bearing. We have frequently seen unprotected orchards barren of fruit, when those well protected were bearing heavily.

SMALL FRUITS BENEFITED.

"The belts and windbreaks are equally beneficial to the growing of small fruits, and in many places they cannot be successfully grown without some protection of that nature. The best grapes are always nearest to the shelter on the north and northwest. Currants, raspberries, strawberries and blackberries are always better for protection on the south and west, and need much less extra winter covering when thus protected, and for the very reasons heretofore mentioned, viz: That windbreaks protect from cold, retain snow in winter and retard evaporation of moisture in summer. In many localities in this state it would be about out of the question to raise strawberries without the protection of a timber belt or hedge.

KITCHEN GARDEN WARMED UP.

"Also the kitchen garden is greatly benefited by surrounding it with a timber windbreak. The soil becomes warmed up and in condition to plant earlier, most varieties will generally mature earlier and the yield will be larger and the quality better.

LOCATION OF THE WINDBREAK.

"If the country is nearly level, it is my opinion that a windbreak upon the west side of the orchard or fruit garden is always beneficial, also on the southwest and northwest; with ground sloping to the south and higher elevations adjoining, or near by on the north, the windbreak should be upon the south and southwest sides, and omitted on the north, except for grapes, strawberries and vegetables. In ground sloping to the north and northeast—which is generally recommended—the windbreak should be on the north and northwest sides, and if practical the north belt should be upon ground

somewhat higher than the lowest part of the orchard. In all cases it would be better if there could be a strip of ground between the orchard and the shelter, provided it is a little lower than that upon which either of them stand. No greater depression than can be made by two or three plowings of the ground, finishing in the same dead furrow, will answer a very good purpose. Windbreak upon the south side of an orchard may safely stand nearer than upon other sides, but in no case should a break and orchard be so near together that the roots of the trees comprising them will eventually run together and rob the soil of the nutriment and moisture needed for the well being of each other.

DISTANCE FROM THE FRUIT TREES.

"The inner line of the break on the north side of an orchard should be at least 15 feet inside of the next line, and far enough from the fruit trees to prevent reflected heat reaching back to them, and the trees in this line are better if not standing too close together.

BROAD AND OPEN BREAK.

"For the orchard alone I think a broad and rather open break of evergreens and deciduous trees mixed would prove the best; for most other purposes close planting is probably the best."

For a farm residence it would be a wise arrangement to have the windbreak of which Mr. Harris speaks, extensive enough to enclose not only the orchard, but all the home buildings, lawns and gardens. Too many trees is the "vice of excess," about as pernicious as the "vice of defect." As a general rule the groves around the farm houses on the prairie—if such exist at all—are too close and shadowy for good circulation, sunlight and healthfulness; always making troublesome snowdrifts. They should be distant not less than two hundred feet from the house in the narrower part of the plat. Well to have the inside space a third longer than wide. But beyond and outside of all the screens and open breaks, on the farm boundary, especially on the southern and the western sides, or where the cold and hot winds generally prevail, should be a broad dense one.

CONSTRUCTION OF THE GENERAL WINDBREAK.

Plant two rows of white willows on the outside, four feet apart and eighteen inches apart in rows. Then a space of about forty feet wide. There is where the snow is trapped in a huge, long drift like a sand dune. On the inner edge of this open space, plant say, two more willow rows as before. You must expect snow will break down many a willow limb, but this tree stands the racket, and will send up new trees next spring, keeping the continuity of the belt. Now regular rows of other hardy trees four feet apart, promiscuously mixed for mutual protection and forest symmetry—the ash, elm, and box elder predominating, with here and there a soft maple, a black cherry, and a basswood. Under the protection of these have some

walnuts, butternuts and oaks, and inside of all, at distances not less than two rods apart, rows of pines and spruces.

WINDBREAKS ALONE INSUFFICIENT.

The correlation of the atmosphere with the soil is such, that, if the latter is not properly treated by methods before described, in vain may trees dispute the power of the winds. As is well known, hot winds do not materially injure plants until their high temperature, dryness and velocity have drained the soil of moisture. So long as moisture remains in the soil in sufficient quantity to feed the roots, though the hot winds may scorch the tips of the blades and cause a wilting down, the plants often recover at night, and are generally found to be not seriously injured,

DOWN POURS OF HEAT.

Prof. I. M. Cline, of the Texas Weather Service, endorsed by other scientists, observed that atmospheric heat sometimes travels in narrow currents, ranging from one-hundred feet to half a mile or more in width, and are evidently down-pouring masses of dense, dry air, heated dynamically in descending. It is not to be inferred from this phenomenon which some of us have observed and most sensibly felt, that the condition of the soil of the country over which these burning currents sweep, is not a factor concerned, for no such currents obtain in the vicinity of dense timbers; their origin, therefore is traceable mainly to treeless, arid regions.

HEAT ACCUMULATIONS.

The diminishing pressure of the air over our vast prairies to the northward, centering on the sun-burned treeless regions far beyond the international boundary, is the condition inductive to our hot southerly winds.

Clouds or any form of mists serve as furry blankets over the soil, keeping it largely from evaporating its moisture and mitigating the rigors of heat, where these vaporous conditions do not obtain and the skies are clear for days and weeks, the conduction and radiation of heat are quick and intense, giving rise to the low, barometric pressure and southerly winds that pelt us so. In an able paper on this subject, read before the Chicago Meteorological Congress, Prof. Geo. E. Curtiss says: "Hundreds of miles of hot, dry earth contribute to maintain and feed the current and gathering strength, as the sun mounts higher, of the hot winds sweeping over the defenceless prairie. The surface is heated to the high temperature necessary to the development of hot winds only where the ground is dry. The sun's heat falling on a moist soil is largely used in the work of evaporation, whence the accumulation of heat and the rise of surface temperatures, which would take place on a dry surface, is to a great degree prevented. In support of this, we find that the hot winds do not arise when the soil is moist, and that a rainstorm quickly brings them to an end. Conversely, the reports bear uniform testimony to the fact that periods of drouth are periods of hot winds, and the more prolonged, the more continuous and intense do they become.

All methods of cultivation which directly or indirectly help to increase or retain the moisture in the soil, will tend to ameliorate both the hot winds and their effects."

KNOTTY OR CLEAN TREES—WHICH ?

Generally the terminal buds are stronger than the lateral ones; hence, the former lead, developing upward. This elongation is from the top or terminal bud; so that the distance from the base of the tree to the first limbs never changes, so long as the limbs remain on. To lengthen the tree-shaft, rub off the lateral buds, when the tree is a mere seedling, or cut off its lower limbs.

HEARTWOOD.

Heartwood or pith answers to the tree what the spinal cord does to the human body; the former sending off shoots that terminate in buds and limbs, the latter in nerves that ramify every part of the body. It is important that the pith be kept in a healthy condition, though it is not absolutely necessary to the existence of the tree, since it builds itself on the outside under the bark.

HEART-ROOTED STUBS.

As stated, a bud develops into a limb. That bud is a projection of the heartwood. The slender stub, whose external projection dies in deep shade, is as much an integument of the heartwood as is a nerve of the spinal column. When the little limbs drop or are properly cut off from a healthy tree, the inside stubs remain perfectly sound, and under the "bite" of the healing bark, analogous with the human skin, the wounds speedily close over, and the living stubs are generally converted into clear grain wood. If the lower limbs remain to old age, decaying more and more, as they are apt where there is no shade to educe early self-pruning, the timber of the shaft is knotty, much to its commercial discount. In pines such knots are frequently encircled with a resinous substance, falling out when the log is cut into boards. In some trees, especially the broad leaved, the old stub is apt to die outright. Then the rain drips in and fungi grow there, the rot eating into the heart, greatly shortening its life and injuring the value of the tree. It is plain that all these misfortunes can be averted, only attend to it in season.

ROOT GROWTH OF TREES IN WINTER.

Fred Nustbaumer, of the St. Paul public parks, says: "If the earth gets cold, the tree cannot form rootlets in sufficient quantity to retain its vitality during the winter. This seems, perhaps, to be rather queer, as a good many of you think that the tree does not need any sustenance during the winter, but it is nevertheless a fact that it needs a great deal of it, for the reason that every bit of sap evaporated by hard freezing weather must be counterbalanced and furnished by the roots to prevent the tree from getting winter killed. The tree, while in dormant condition, is by no means

lifeless, and the hard winter's frost has more strain on its vitality than perhaps the hot summer's sun. This is reason enough why we should not plant any sort of trees in the fall—not for Minnesota."

RELIGIOUS VANDALISM.

Says the New Jersey Forester: "The growing of Christmas trees for market, would be, if properly conducted, a legitimate and, no doubt, profitable business. Although the custom is time honored and gives pleasure to children for a few days, it seems a shame to sacrifice thousands of beautiful young trees for such a useless purpose. There is hardly an old field in Southern New Jersey which does not show the work of Christmas thieves. They cut down the thriftiest cedars as soon as of a marketable size, and cut the tops out of full grown trees. All this is to celebrate a custom, the meaning of which nobody exactly knows. The city of Paris uses 40,000 Christmas trees each year."

The timely suggestion of the New Jersey Forester is what the writer of this has all along advocated, especially in his last report. Were we not right? Millions upon millions of young and most beautiful spruces and balsam firs are annually cut and shipped in carloads over the northwest, supplying even Chicago. This destruction of our most promising trees passes for a proper celebration of a religious anniversary. Let us not discount its beautiful significance, but if we must use trees, then raise them for the purpose and stop churchal vandalism upon what is absolutely needed to preserve our evergreen forests.

FOREST GARDENING,

One of the great discouragements to many farmers in planting trees is the fact that they cannot, in their day, reap the profit of timber maturity, for it takes a hundred years or more for our most valuable ones to perfect their qualities for the market. It would seem that a patriotic love of country, made prosperous by trees, should be consideration enough for such investment. But the genius of foresight seldom obtains unless immediate or available profit in the near future is assured. If such men would pause and think, study and plan with a view to profit alone, and then push ahead in the tree business, they surely would find their forest patch is, all things considered, ten times more profitable than an equal area of agricultural products.

COPPICE.

Coppice is a growth of timber from a former stump, usually cut before maturity at special periods of time, according to circumstances and the uses to which the product is to be applied. The object is to make the most profit out of the forest with a view to reproduction at the least cost and the least injury to the plantation.

Coppices cannot be successfully produced from the stools of pines, but they can from those of ashes, elms, oaks, soft maples, larches, willows, bass-woods, birches, alders, cottonwoods, poplars, locusts, and most of the other deciduous trees.

As stated in a former article, where the object is profit-improvement cutting to regrove the trees from the stumps, studious care must be used so as not to injure the cambium of the bark, whence sprout the new shoots. The cut must be smooth and on a slant downward to prevent collection of moisture, leading to decay, and as close to the ground as possible, so that the sprouts can form independent roots for new trees.

It will not do to depend on sprouting alone, for repeated cuttings of this kind will in time run the stock out, the original roots failing to reproduce. Hence, seedlings should now and then be planted, and the layering of sprouts attended to, as needed to fill up the gaps.

REPEATING THE CROP.

The trees can be cut over again at periods varying from ten to thirty years, according to the growth of the species. It is obvious when the planter has a large variety to draw from, constituting a more perfectible forest, he can cut some for profit-improvement nearly every year, and find an increase of demand at every turn he makes. A few opportunities for money making along these lines are here adduced as encouragement for more extensive tree planting on the prairie.

SUPPLIES FAST EXHAUSTING.

"The entire forest area of the United States, according to the best authority," says Hon. W. W. Barrett, State Supt. Irrigation and Forestry, North Dakota, "is found to be less than five hundred million (500,000,000) acres, yielding an annual cut of near twenty-four billion (24,000,000,000) cubic feet of wood material per annum, giving an approximate value of one billion (\$1,000,000,000) dollars. This is an enormous amount, being more than the total value of the annual crop of wheat, rye, oats, potatoes, cotton and tobacco produced in the United States. The estimated consumption, based upon census and other figures, is near twelve billion (12,000,000,000) cubic feet of wood material in excess of yearly growth. To this must be added the loss by fires, estimated to be five billion (5,000,000,000) cubic feet per annum, on an average. This great cut and loss, each year, if placed in a compact body would make an area of not far from thirty millions (30,000,000) of acres, or near three-fifths as large as the great state of North Dako-

ta. And the increase of consumption is near 30 per cent. each decade. Thus at the present rate of consumption, with no increase in any way of domestic culture, it is calculated by those best informed upon the subject that the entire timber of the United States will be utterly destroyed long before another century shall roll around. Hence the absolute necessity of a new awakening in the subject of forestry, the conservation of the present and the planting and cultivation of more timber throughout the Union."

SURETIES OF MONEY MAKING.

These vast consumptions, while alarming, are sureties of money making to those who engage in forest gardening. Look at some of these figures on this line. According to U. S. Statisticians, 300,000 new telegraph poles are annually cut and erected; 3,000,000 cords of wood consumed annually for brick making alone; 100,000 cords of soft maple for shoe pegs; 390,000 cubic feet of pine for lucifer matches; 1,000,000 cords of birch for boot lasts and tool handles; 500,000,000 feet of spruce for wood pulp. Do not such enterprises—and they are fractions of great wholes—give assurance of profit in wood culture?

BARK INDUSTRY.

Safe gains these days of competition come from economizing to the minutest parts. Bark for tanning purposes pays. Profit can be derived from the leaves of our common sumach for tanning white morocco leather. The bark of our white and red oaks, raised as coppice, when not more than fifteen or twenty years old can be profitably used for tanning and the peeled woods for tool handles and spokes, and the refuse for fuel. Do you know the value of willow bark? It tans the beautiful Russian leather, and is used in varied forms of medicine. There is profit in the bark of alders that can be raised extensively on our abandoned wet places.

CHARCOAL INDUSTRY.

Coppice hard woods are in demand for charcoal to be used in our innumerable smelting furnaces. Where are our planted trees that can be spared to supply the paying demand? It is also wanted for a filtering and deodorizing agent. It is wanted from our dogwoods and alders and willows for gun-powder. Even the smoke, arising from the charcoal manufacture, has a value in the market, containing as it does a methylic alcohol convertible into "wood vinegar," and by other chemical processes into useful acids, among which is an acetate used in the formation of white lead. It has been estimated that a cord of dry hardwood converted into charcoal for iron-smelting purposes, the smoke of which is utilized, will give a total of \$9 to \$10.

TAR AND PITCH.

Why must Minnesota depend entirely upon the southern states or European countries for tar, pitch and turpentine, when we have trees that can

be appropriated for these purposes? Immense quantities of these substances are manufactured in the North of Europe and Siberia from the Scotch pine that we can and do successfully raise on our prairies and sandy places of Eastern Minnesota. The process of manufacturing the tar is so simple and almost costless, any one can profitably engage in the industry. "A hole is dug in the side of the bank in which billets of wood are heaped up and covered closely with turf or earth; a fire is then kindled from below and the slow combustion causes the tar to exude from the wood and flow out from the heap into barrels placed below to receive it." By distillation and other chemical arts it is converted into wood vinegar, creosote, oil of tar, and a residue of pitch.

WOOD PULP.

Pulp was used first only for the manufacture of paper; now-a-days it is transformed into tubs, pails, barrels, water pipes, wash boards, kitchen utensils, doors, caskets, flower-pots, horse shoes, carriage bodies, floor coverings, furniture, building ornamentations, and various other useful and beautiful structures. Indeed, textile material resembling leather, cloth and silk have been manufactured from it. It forms a protective armor to torpedo rams. Bullets for rifle use are made of it. An entire hotel in Hamburg, Germany, has been constructed from it. Food products are derived from it, also alcohol. There seems to be no end to its uses. As the soft woods contain more cellulose than the hard woods, the former has as yet the higher commercial value.

According to statistics of the wood pulp industry of the United States, 1890, there are 237 mills, having a total capacity, mechanical and chemical combined, of developing daily 4,000,000,000 pounds of pulp. In the last eight years the business has increased nearly 500 per cent. In 1888 the pulp stumpage was valued at \$2,235,000; the ground product was estimated at \$12,375,000. The figures also show that the present consumption of wood per annum for pulp is 1,000,000 cords. The percentage goes up with the increase of demand, and in a few years more, millions of cords will swell to billions. It is successfully manufactured from poplar, spruce, pine, willow, bass-wood, cedar, hemlock, soft maple and birch. At present, the first two kinds are mostly used. They are both easily raised on the prairie. Whoever engages in developing them is sure of good profits from the two latter trees, especially when they are but ten to fifteen years old.

WILLOW WARE.

The business of raising willows for certain kinds of furniture and baskets is growing in importance in our country. The common osier, *Salix Viminalis*, has pliant shoots well fitted for weaving hoops and baskets. The red osier, *S. rubra*, is much cultivated in Europe for the manufacture of crates, heavy basket and barrel hoops. *S. purpurea* has shoots and leaves so bitter, rabbits and other animals will not eat them; hence makes a good fence. The cultivated shoots are long, clean and pliable, and very popular

for basket work. It is sometimes called whip-cord or swallowtail willow. *S. triandra* produces very white rods when peeled, which can be split up very finely, so as to be used in the finer kinds of basket, chair and wicker-work. These two last are well adapted to our climates, succeeding well on low wet or rich, high, dry lands.

Under ordinary circumstances cultivated willows, even during the first three years, will produce 3,000, to 5,000 peeled willows per acre; usual price ten cents per pound, wholesale. Raised from cuttings. Plow and cultivate as for other plants. Set them one foot apart in rows three feet apart, press the top bud down at least one inch below the ground surface. This is a good rule for planting any tree cuttings. In removing for the market, the shoots are cut close down and even below the surface, so that no stumps or stools are formed. The whole field can be afterwards harrowed safely for the roots. The cost of properly preparing the land and planting ought not exceed \$115 to the acre; to this must be added the cost of the cuttings, which is between twenty and twenty-five dollars to the acre.

PROFIT OF RAISING BIRCHES.

Though our white birches often monopolize our burnt districts and other denuded lands, excluding more valuable trees, they there offer new remunerative industries. White birches, even down to two inches diameter, are utilized these days. An enterprising firm in Alpena, Mich., annually manufactures 15,000,000 thread spools from these young trees. In Maine the industry is of equal importance. If the cutters will only manage for coppice crops, as herein instructed, they will have a permanent paying business in this line, at the same time preserving the continuity of the forest. These trees can be easily raised by the millions on the prairie.

OTHER USES OF SMALL TREES.

Hoop poles, hop poles, telegraph poles, railroad ties, all such have a market sale. Even umbrella and walking sticks are called for, and suitable for this purpose, are our young red and jack pines, spruces, birches, elms, maples, oaks, box elders, diamond willows, etc. In two or three years some of these will be large enough to cut. Presenting this industry as a lucrative one, Chicago "Hardwood" says: "America furnishes a great variety of woods and canes for both walking and umbrella sticks, and a number of concerns make a business of collecting and dealing in them, and a large number are exported to Europe, while a much larger number are imported from every quarter of the globe. Millions of young saplings from the forests of the United States and Mexico, and canes from the brakes of the South, are consumed annually in the trade."

RAISING HAZELNUTS.

The fall of 1895 the State Forestry Association sent out over 40,000 native hazelnuts, *Coxylus Americana*, mailed in packages of 100 each, free to

citizens of Minnesota, exclusively for trial in the prairie regions. On testing their soundness, soon after gathering them, we found more than 75 per cent were worm-eaten, showing they are nuts that, like acorns, must have special treatment in their incipient stages by vigorous applications of insecticides. This done, raising them for the market, as well as for the home to "crack o' wintry nights," can be made to pay well. It is stated an average crop rightly managed, is about 1500 pounds per acre, and the usual price in the market 20 cents a quart. In their thrifty condition they do the best when standing from eight to ten feet apart. A larger crop and better quality are secured if the plants are kept measurably dwarfed. They should receive the ordinary care of other orchard fruits. Those in their wild state, growing in thickets and margins of our woods, are not as large as the properly cultivated, but all such are smaller, yet sweeter, than some of their improved varieties.

There are numerous varieties, which may be classed under two heads, nuts and filberts. The husks of the latter are much larger than those of the former. There are different varieties also of the filberts; some have long and some short nuts; the latter bearing the name of cobnuts. The Spanish or Barcelona nuts are most sought. Trade in them is immense, about half a million dollars worth being annually imported into England alone. They are equally popular in our country. It is doubtful if the Spanish filbert can be raised in our climate. We better rely upon what is indigenous. There is a species of filbert growing in some sandy regions of Wisconsin, also on Turtle Mountain, North Dakota. On further research we may find them growing wild in our northern woods. The plants can be procured from suckers or layers, as well as from the nuts. Being valuable brushwood protection to our forest trees, and bearing delicious nuts, always in marketable demand, it is to be hoped that this hardy shrub will receive the attention it deserves.

TEST OF THE FITNESS OF TREES.

One of the most promising features of successful forestry in connection with horticulture is the divisional work of the Experiment Station at St. Anthony Park, located at different centralized portions of the state. The one in Lyon county has made a most promising beginning under the management of K. B. Norswing. Soon as the divisional station, located at Crookston, Polk county, is in working order, the people of Northwestern Minnesota can readily learn what trees are adaptable there. Another one is soon to be located in some wooded portion of Northeastern Minnesota. Testing the fitness of our trees and fruit plants for special territory is a sure guarantee of practical forestry and horticulture under diverse environments.

The following trial list of trees furnished by Prof. Green, planted at Coteau Farm, Lyon Co., spring of 1895, by Horticultural Division of Experiment Station, is given, not as a positive proof of adaptability in every case, but to demonstrate how fast and solid we are moving on the forestry lines. As the trees were selected for hardiness, the probability is that most of them will prove worthy of recommendation for all that region.

<i>Acer dasycarpum</i> ,	Soft maple.
" <i>saccharinum</i> ,	Rock "
" <i>platanoides</i> ,	Norway maple.
<i>Betula alba</i> ,	European White Birch.
<i>Celtis occidentalis</i>	Hackberry.
<i>Fraxinus viridis</i> ,	Green Ash.
" <i>sambucifolia</i> ,	Black "
<i>Juglans nigra</i> ,	Black Walnut.
<i>Morus Tartarica</i> ,	Russian Mulberry.
<i>Negundo aceroides</i> ,	Box Elder.
<i>Populus alba</i> ,	White Poplar.
" " <i>var nivea argentea</i> ,	Silver "
" <i>monilifera</i> ,	Cottonwood.
" " <i>var Van Gertie</i> ,	Van Gert Poplar.
" <i>certinensis</i> ,	Russian Poplar.
<i>Prunus serotina</i> ,	Black Cherry.
<i>Pyrus Americana</i> ,	Mountain Ash.
<i>Quercus macrocarpa</i> ,	Burr Oak.
<i>Salix Alba</i> ,	White Willow.
" <i>vitellina var aurea</i> ,	Golden Willow.
<i>Tilia Americana</i> ,	Basswood.
<i>Ulmus, Americana</i> ,	White Elm.
" <i>racemosa</i> ,	Rock "
<i>Abies balsamea</i> ,	Balsam Fir.
<i>Pinus strobus</i> ,	White Pine.
" <i>sylvestris</i> ,	Scotch "
" <i>ponderosa</i> ,	Bull "
" <i>Mughus</i> ,	Dwarf "
" <i>resinosa</i> ,	Norway "
"	Jack "
<i>Picea</i> ,	White Spruce.
" <i>excelsa</i> ,	Norway "
" <i>pungens</i> ,	Colorado Blue Spruce.
" <i>Englemanii</i>	Engleman's Spruce.
<i>Pseudotsuga taxifolia</i> ,	Douglas Fir.
<i>Juniperus Virginiana</i> ,	Red Cedar.
<i>Thuja occidentalis</i> ,	Arbor Vitæ.
<i>Larix Europea</i> ,	European Larch.
<i>Robinia pseudacacia</i> ,	Locust.

Rhamnus Catharticus,
Cornus stolonifera,

Buckthorn.
 Red Dogwood.

CORRESPONDENCE.

From Felton, Clay County.

In a letter to F. S. & H., assigned to me to answer, Joseph Bangtⁿ mentioning his fine grove of cottonwoods, says:

"They are a soft wood and won't last long. Would like to plant acorns, but do not know how to prepare them. I cultivate my trees till they are three years old, then I mean to plant grass seeds in the patch, and with the grass would like to plant acorns, so that when the soft wood is cut off I may have a young growth of longer lasting timber to take its place."

If all our other tree planters would "go and do likewise," our groves and windbreaks would soon be like virgin woods, grand and permanent in their variety when not spoiled by the ax-man and the fire. You better not sow grass seed in that patch; grasses bind and choke the very life out of our prairie trees. They prevent water percolation and air circulation. In lieu plant various fruit-bearing shrubs, such as sand cherries, wild raspberries, gooseberries, dewberries, highbush cranberries, hazelnuts and whatever else may be useful for berries and for protection to the roots of the trees, holding the rain and snows, and keeping the soil soft and friable for vigorous tree growth. In the woods nothing conserves the moisture as living mats of shrubs, mosses and leaves. Acorns easily dry up when exposed, destroying germination. Plant soon as gathered from the tree. If your cottonwoods are densely shading, thin out the forest in the summer following the replanting, and allow sufficient sunlight with the necessary shade for the new candidates. Take into your practical judgment this fact, that the better class of trees you plant cannot, when young, cope with the pioneers during the ordeals of extreme cold and hot winds. The more shady and less valuable trees must stand as protecting guards over the little fellows struggling for existence. Thinning must be according to their needs, giving the "elect" the advantage for growth. Do not thin in the fall, winter or early spring. If you thin before the sap starts, numerous shoots will grow from the stools, making your cottonwood grove denser than before—a condition of shade defeating your object. It is not wise to exclude entirely the light-needing from the shade-enduring trees; let them both stay in our prairie groves, but give the "fittest" the supremacy, such as the ashes, elms, oaks and pines. We cannot afford to run the pioneer woods out of use.

From Cottonwood, Lyon county.

J. C. Townsend commenced tree planting in 1878, and is "at it yet." His plantation is in the shape of an L, the longest side north and south, cutting the western winds. It covers about seven acres, consisting of cottonwoods, white ashes, soft maples, box elders, (which four he recommends as leading) willows, white elms, oaks, basswoods, butternuts, walnuts, ironwoods, evergreens, plums, "ranging all the way from three inches to fifty feet high." He thinks "one sixteenth part of every section of the prairie lands should be planted to trees." Where vacancies occur in his plantation, he puts in walnuts. Has now half an acre or more planted with this tree. Says he "will get there after a while" and that he "would rather have twenty acres of walnuts in good bearing condition, than the profits on eighty acres of farm crops, for the walnuts are a lasting profit for the next fifty years." He evidently loves his high calling, "making more beautiful our homes, enhancing the value of our farms and softening the ragged edge of the Minnesota blizzard."

From Ibsen, Wilkin county.

E. C. King reports that very few trees are planted in his town, being newly settled. He says: "In 1890 I planted 3 000 yellow cottonwoods which are now from ten to fifteen feet high. In 1891, I planted about the same number, besides a large quantity of ash seed each spring, also willow cuttings, box elder seeds, Russian Mulberry, English buckthorn. The late frosts of last May, 1895, killed about 2,000 of my young trees. For wind-breaks I would advise planting yellow cottonwoods, two feet apart in the row, and the rows eight feet apart, and between the four or five rows, planting wild plums, cherries, gooseberries, grapes and other wild fruits. Would advise planting different kinds of trees, such as box elders, ash, elm and aspen to make a handsome grove."

Mr. King is setting a good example in the tree business for his neighbors to copy. To forestall damage by the frost, use the smudge—anything that will make a wide-spreading smoke.

From Breckenridge, Wilkin county.

Trees planted in this locality that have not had good care are generally a failure. They need better care than is usually given a corn field. The mistake many make is in ridging the dirt about the trees to cover grass and weeds and usually that is the end of cultivating. The prairie sod, dry weather and fires do the rest. Those commonly planted here are cottonwood, box elder, ash, elm, willow, and balm of gilead. I prefer them in this order: Elm first, then ash, cottonwood, box elder, balm of gilead and willow. The worms trouble the willows so much that they are not desirable in many seasons, and even the box elders will die from some cause. Think it is principally a lack of moisture. A few rows of cottonwoods and, adjoin-

ing on the south, several rows of wild plums make a fair windbreak. Evergreens, so far are generally a failure here.

H. E. BAILEY.

That's a "new fad"—ridging the dirt about the trees to kill the weeds and grass! No wonder those farmers fail. Why, it should be right the reverse—the ground hollowed out a little about the trunks so that the water may drip down the roots.

From New Ulm, Brown county.

Hon. W. H. Heideman reports that "J. F. Neumann will utilize ten acres of his farm near the river in planting hickory and walnut trees." Will Mr. Neumann report his success and method of management? There are several walnut orchards in the more southerly portion of the state. It would encourage others if the proprietor will give reports to the secretary of the Forestry Association. It is estimated that walnuts alone pay far more than apples from an orchard of equal area. A walnut orchard is far more hardy and durable. When the trees reach their maturity, and are allowed to grow tall and timber-like, each tree is worth on an average, all of fifty dollars.

From Ashby, Grant Co.

Tree planting here is in a very rudimentary state, most farmers being contented with a few rows on the north and west side of their dwellings. For this purpose the box elder and cottonwood are the most popular as well as the hardiest. White willow, although not so commonly planted, is also perfectly hardy. Ash and elm also do well, but are not planted to any extent and not for windbreaks. Lombardy poplars were quite popular on account of their rapid and erect growth, but the oldest ones are now fast dying out and people have quit planting them. Oaks are not planted but are very common in our woods. They would no doubt succeed if planted under right conditions.

A. E. STENE.

Raising the Lombardy poplar is a waste of money and labor. It is pretty for a few years and then becomes a miserable looking thing.

From Redwood Falls, Redwood county.

James Longbottom has a tree plantation of his own raising that is now 22 years old, covering 15 acres, consisting of white ash, soft maple, black walnut, elm, box elder, white willow and cottonwood, all of which he considers reliable except the cottonwood, a large number of which is dying these late years of dryness. He, too, started his forest in a cornfield, growing corn with the trees for two years; worked the ground till the trees were eight to ten feet high. "They now average a foot in diameter; some of them are over two feet in diameter." Mr. Longbottom shows how sure is success on the prairie, when tree planters manage rightly. With others he thinks one-sixteenth of all our prairie lands should be planted to trees. He has "given away thousands of young trees to new settlers, for trees growing look more like making a home."

From Brooklyn, Hennepin County.

The soil in our town is light and sandy, and since the woods have been cut away, it drifts badly at certain seasons of the year. We have decided to plant a grove. We planted a lot of elm and soft maple seed last summer, which have made a good growth.

MRS. ROSA B. GREEN.

From Anoka, Anoka County.

John R. Barrett, reports terrible winds in his sandy part of the state, 1894, sweeping out the corn from the ground in all exposed places: "Trees, trees, O for trees to protect us from the scorching, blighting winds. My trees have saved me, yet I need more and will have them. My neighbors, having less trees have suffered the more; some lots ruined or nearly so. In some instances the wind dug deep holes in the ground; acres of them. Trees, trees, trees we must have, else this land will be a desert waste in a short time."

These two cases of sand drifting are by no means isolated or exceptional. Fast as the forests are destroyed in such soil, so accumulate the calamities just mentioned. Replanting trees is the only antidote. See management of sand dunes, &c.

From Hendrum, Norman County.

Evergreens here are only experimental. The few I have are neither dead nor healthy. Scotch pine seems to have a good complexion; so the Norway spruce and a species of the arbor vitæ. Of deciduous trees, my favorites for the bleak prairies are the elm, ash and northern grown cottonwood. Other good trees of rank growth and fine appearance here are ironwood, basswood, box elder, wild plum and choke cherry.

OLE J. HAGEN.

By the protection of forest trees and proper soil and culture management, Mr. Hagen is making encouraging experimentation with fruit plants in his region of the Red River Valley. He calls attention to the northern grown cottonwood, claiming it is superior to what we have farther south.

From Arthur, Traverse county.

"I did not plough or cultivate the ground in any way in the spring before planting, desiring to let it remain firm so as to exclude air in too great a degree from the roots of the trees, and to guard against undue evaporation. I planted the trees on the east side of each cornstalk hill and close to same, being four feet apart, which saved the necessity of marking. The object in planting particularly on the east side of the corn stalks is, first to keep the trees in straight rows; second, that they may receive the morning and forenoon sun, and be protected or shaded from the scorching rays of the afternoon sun.

JAMES H. FLOOD.

Aside from the advantages cited by our correspondent, corn belongs with that class of plants which extracts from the air nitrogenous properties which the young trees need, also in a special manner fits the salts in the soil for root development, ensuring healthful growth.

From Wells, Faribault county.

Moses H. Bragdon has a small seed planted nursery and is setting a common sense example for other farmers to copy—"raising white pine trees from seeds."

From Glyndon, Clay county.

C. H. Bassett proves that even the walnuts, with proper treatment, will do well on or near the 46th parallel. He says: "It may be in order for me to say that we have growing in our yard, walnut and butternut trees which bore seed the past season, as they have done before. The nuts were planted where the trees now stand."

From Redwood Falls, Redwood county.

"I have 200 butternut trees 5 years old from 1 to 2 inches in diameter and from 3 to 5½ ft. high. They are not thrifty, and winter kill at end of the branches. Have mulched them this season with coarse manure, but it has had no effect yet on account of the dry season."

FRANK E. KENNEDY.

I have known them to kill back so year after year, but afterwards get acclimated and sound to the terminal bud. Protect them on the windward side.

From Great Falls, Montana.

Think of what H. O. Phillips is doing in the arid regions, "O, ye of little faith!" "I have about 400 box elders raised from the seeds upon the bench land without irrigation. I put the seed in three years ago and have now trees from three to five feet high."

From Brunswick, Kanabec county.

S. E. Tallman, lumberman, calls attention to township 38, range 25 of his county: "It is the best and cheapest site for experimenting in reforesting that I know of anywhere within reach of St. Paul and Minneapolis. The land having once been heavily timbered with both pine and nearly every variety of hardwoods, by replanting such on the land formerly occupied by same species of timber, we would be assured of the best results, with the least chances for failure; then the large number of dams built by the beavers and also those built and now abandoned by lumbermen could be repaired, which would make the water question almost a certainty."

Why cannot he and other business citizens of that promising region of our state, project a movement that will secure eventually a vote of the people of his county to make a forest reserve of that township, owned and guarded by the county?

From Lakeside, Renville county.

N. A. Vanmeter, working for a "grove in embryo," promoted by the Forestry Association says: "Am enjoying a soft maple grove of 800 trees, which I set out in 1870, also 10,000 white willow put out three to seven years ago. I set out some nearly every year and cultivate them like corn."

From Otisco, Waseca county.

Eli Bishman says he has from time to time transplanted small oak trees, different sizes, but "when Sept. comes they always look dry." September is generally our dry month. In transplanting young oaks the tap root generally has to be cut off, leaving comparatively but few fibrous feeders to support the trees. Hence, the safest way for raising any of the tap-rooting trees is to plant the nuts. But you can surely raise oaks from acorns by making a bed, say six inches deep, on a brick or plank pavement, and planting the acorns there, keeping the soil properly moist. The roots will then spread themselves out horizontally, safe for transplanting next year.

A word about the Jack oak acorns sent for trial in the fall of '94. Reports are various, some that they sprouted up and are doing well. Thos. H. Smith of Noxon, Montana, states his grew the first year three feet high. But most of the returns are unfavorable. Doubtless a large number of them dried in the embryo while in transit, or while in the dry ground at the start. I was unable to procure any this fall, '95. To compensate for the disappointment I mailed hazelnuts to most of the applicants this fall, all I could purchase, and failed to complete the list. Some other kinds of seeds will be sent to the balance.

John Soldner, of Cashel, Minn. states that "owing to the dry month of April the most of them came up between the 15th of May and the 15th of June. I have now 76 growing out of the 100. I think about 90 came up, but the cut worms took some. The seedlings were given no special care, except to keep them from being smothered by the weeds. They are now 5 to 6 inches high." Reporting his general tree planting, he adds that he "commenced tree planting last year; have growing 1,100 of box elders, ashes, maples, elms and cottonwoods; 1,500 seedlings for next spring's planting, also planted 800 willow cuttings." This tree protection has also given him "a fair start in small fruits."

From Graceville, Big Stone county.

In '92 and '93 Henry Hanson planted two windbreaks on his farm, one in a rectangle, the other L shaped; the trees consisting of box elder, white ash, elm, white willow, cottonwood and jack oak, making about eight acres. He considers the three first are leading trees for the prairie, and his judgment is to be credited, for he succeeds in raising trees. After planting in a sensible way he studiously kept his forest plantations free from weeds and grasses by frequent use of the hoe and cultivator, stopping such work the first part of July. In case grass became troublesome, he mulched such

spots with straw and killed it out. All his trees have had vigorous growth. Says he "has trimmed a part and think I will trim the rest." See reasons in this treatise why he should not do it except when specially necessary to remove defects in growth. About twenty-five per cent of the jack oak acorns sent him "seem to be doing well."

From Buffalo Lake, Renville county.

N. L. Monson says: "As we have a small grove of swamp oak, I have been thinking of grafting some jack oaks on them, if it can be done. It would make a good windbreak without waiting for slow growth of seedlings."

Practical if the two trees generally agree to the union. I would select young trees, and for cions have this year's growth.

From Supt. Public Instruction.

St. Paul, Minn., October 16, 1894.

My Dear Mr. Barrett.—The Forest Tree Planters' Manual, which you kindly sent me, is a valuable book for the purpose for which it was designed. Every one interested in tree growing—and this should include everybody—can learn something to his advantage from your unpretentious little volume. I know I shall make good use of it myself and that others can.

Suggestion—The trouble with most of our shade trees, is the drouth in late summer and early fall. Would it not be well to remark that arbor-vitæ, balsam fir, white birch and many other trees—designating the varieties—will not stand protracted dry weather, excepting favorable soil? Would it not also be a good plan to say that Scotch pines, dwarf mountain pines, buffalo berries, sand cherries, etc., will live through any drouth they are likely to encounter in Minnesota?

W. W. PENDERGAST.

The prolonged and severe drouth that summer and early fall has given our plants a severe strain to live. It will prompt people of our dry climate to be very choice as to selection. I have noticed that the ash has withstood the drouth better than any other deciduous trees, and that too, in diverse soils. This is doubtless due to the fact that the evaporative power of the ash is small compared with some other trees, and naturally has a long, penetrating tap root that will find moisture if it is in the ground. Adaptation to soil is a very important matter. Let the reader note what Prof. P. says as to reliable selections for drouth conditions.

From Clinton, Conn.

As the following letter is important for the friends of forestry, I publish it entire. Prof. Northrop is the originator of the "Village Improvement Society," and is a most efficient leader in the right observance of Arbor Day and the sylvan ornamentation of our homes, and is well posted in practical forestry which he defends with a strong brain-battery:

J. O. Barrett, Sec'y. Minn. State Forestry Ass'n.

My Dear Sir: Thanks for the "Forest Tree Planter's Manual," and congratulations on the good work you are doing for Minnesota: Have you

had experience in planting black walnuts? Gov. J. Sterling Morton sent me a quantity grown on his trees. He planted these nuts at "Arbon Lodge." He sent them as soon as mature with the soft shucks on, and with the directions repeated which he gave me when I was his guest at Arbon Lodge, Nebraska City. "Plant soon as possible and five inches deep. Never let them dry." I have thus planted and given to my townsmen. They have done well and are now bearing nuts and have borne for three years. Morton says: "The soft shuck is nature's nutriment for the sprout."

Most cordially yours,
B. G. NORTHROP.

From Halstad, Norman county.

Rev. O. A. Th. Solem, a judicious and successful tree raiser, says: "The best trees for the Red River Valley are such as have been growing wild along the rivers here. We once had red oaks in abundance, also white elm and basswood. There seem to be two varieties of the box elder here, one a light color, and one more dark growing in low places near the river; a poor tree here. The ash is a very nice tree. We have several varieties of native poplar and willow, and in the eastern part of the county, numerous birches."

The Rev. gentleman has a nursery of his own in which he is successfully raising the American and European Larch, European white birch, white willows, Russian willows, white elm. He also has a rich variety of evergreens which as a whole, well endured the drouth of '94. He recommends protecting such by deciduous trees, more especially on the south side, and white willows for outside rows to a windbreak. "The Am. white spruce," he adds, "is a lovely tree, hardy, and a rapid grower."

From Osage, Iowa.

The following extract from a letter in respect to shaping young evergreens for ornamentation, seems to be the reverse of the views given before in this treatise relative to their injury from bleeding. We should be glad for gleanings from all possible standpoints of experience. I endorse the position taken by the Nebraska horticulturists, that "forest trees do best when they prune themselves," and the statement of the French forester, Carriere, that evergreens, even for ornamentation, are safest when allowed to balance themselves, aided by a few art touches of ours to improve their vigor and beauty. Those who want to train their trees to suit their fancy, will find Mr. Gardner's instruction of special value:

"In regard to pruning evergreens, they can be made to grow in any required shape. Suppose the spruces or pines or arbor vitæ are two to three feet high, and you wish to grow them in symmetrical cone shape. When the new shoots have about obtained their full length the latter part of June or early July, cut all the new growth back to one inch for even balance all round. Do not cut the leader. During the remainder of the season, buds will form on the stubs of new growth. Buds will also appear bursting through the bark on the one year old wood, and frequently from the two

years old. But for the cutting back of the shoots these buds would forever remain dormant. If the trees are of considerable size, say five to eight feet and have never been pruned, then, early in the spring, cut off all branches that hang over a lower branch. Make the lower branches the longest, and each succeeding set, as you go up should be shortened-in. At the proper time, when the tree has completed its new growth cut it back as in the first case to about one inch, where it is desirable to do so, to fill up a space, for instance. When transplanting these trees, we nearly always clip the tops in as soon as set to balance the loss of roots. If it is required to trim up trees bean pole fashion, cutting off all the lower limbs one-third the height of the tree, do it early in the summer, then it will give the wounds a chance to heal before cold weather comes. Dead limbs should be cut off and removed at any time. If you wish to dwarf a tree and keep it for many years about the same height, then when you are cutting the new growth back in the latter part of June, cut the leader off also. This clipping back the new growth must be repeated year after year for the best results. The longer it is kept up the more dense the foliage of the tree will be. The cutting off of the new growth is best done with a pair of hedge-shears, blades about eight inches in length, such as nurserymen generally use."

THE BEECH, *Fagus Ferruginea*.

Several correspondents inquire about the beech, wishing to raise them in Minnesota. It is precarious. Failures thus far, with few exceptions, are the rule. It needs special protection and care. Well enough to have it on the lawn; if it survives, it is there very pretty. I have seen whole forests of it in Wisconsin, near Lake Michigan, about on our parallel. The time has not come when we can rely on it for a farm tree. We must first pave the way for its safe advent with our native trees. In the forest it is tall, straight; grayish bark; in the open space where it can live, its branches reach the ground, having a beautiful cone-shaped crown.

GRAFTING FOREST TREES.

To frequent inquiries as to whether diverse species of trees can be successfully grafted, I have to say, No; the trees must belong to the same family, and be affinities or the grafting is a failure. Nor can two varieties of the same family be made by grafting to fruit the qualities of both. The graft simply roots itself in the other tree, appropriates the vitalities of the other tree, and transforms such vitalities into its own, ever preserving its own special identity. There is a very divinity in nature that will not allow us to lose any of her lifelinks by grafting or otherwise. Creations are her own not ours. The greatly desired improvement must be first in selection of varieties—the most healthful and beautiful stock—and evolve higher toward the perfectible through seeds mainly whose flowers were judiciously pollenized. This is the way we obtain better roses, better apples, better plums.

BIRDS AND TREES.

The chief of the division of ornithology of the Agricultural Department has recently made a report on the results of his examination of the contents of the stomachs of hawks, owls, crows, blackbirds, and other North American birds supposed to be enemies of the farmers. His report is said to prove the popular idea to be largely erroneous that blackbirds, hawks and other birds for the slaughter of which many states give bounties, are destructive of crops. Ninety-five per cent of the food of these birds was found to be field mice, grasshoppers, crickets, etc., which are infinitely more destructive of crops than they. Crows are accused of eating corn and destroying eggs, poultry and wild birds, but the examination proves that they eat injurious insects and destructive animals, and that although twenty-five per cent of their food is corn, it is mostly waste corn picked up in the fall and winter. It was also found that crows eat egg shells to a very limited extent, for the time. Crows eat also ants, beetles, bugs, flies, grubs, caterpillars, etc., which do much damage. The cuckoos were also found to be very useful birds.—Field and Stream.

We have thirty species of insects which subsist on our common garden vegetables. Our apple orchards have fifty kinds of insect enemies. Against these regular enemies, the woodpeckers, native sparrows, orioles, bluebirds, thrushes, robins, nuthatches, vireos, and other birds are making steady warfare. For sport and profit men and boys have been engaged killing off these benefactors. Have not many of our American women had a hand in this slaughter of the innocents? It is estimated by reliable ornithologists that over 5,000,000 of birds are annually required to adorn women's and girls' hats! Under the righteous execration of humanitarians *Dece Fashion* has lately taken a backward flop, and that fiendish industry is lessening. As never before we are beginning to realize the sequences of bird killing. Our planted and native forests—what are left—are literally alive with all sorts of vermin, and so our fields and gardens. Having thus unbalanced the order of nature, from very necessity we resort to the poisons. No discrimination can be made here. Useful insects that are pollen carriers, fertilizing the blossoms whence come all future trees and most of our crop food, are subject to the peril of our poisons. Cleanse away the vermin, but in the name of justice and mercy, breed and save the birds; plant and save the forests that we may be blest with birds enough to master the depredatory insects; next breed and save the bees for honey and fertilization. "So long as there are no retreats or building places where the feathered friends of ours can rear their offsprings, we need not look for their aid in fighting our insect enemies."

GAME BIRDS AND ANIMALS.

Despite the law and the vigilance of our game wardens, our wild ducks and geese, our partridges and prairie chickens, our grouse and quails, our moose and deer, our otters and beavers, our bears and foxes and other game creatures are lessening fast as the years come and go. The wild woods, glades, meadows and tree-shadowed waters are their hatching retreats. Is the process of extermination traceable alone to shooting them? That is legitimate when sought for food. But were the sportsman, or hunter, to cease his occupation they will and do recede before the ax and the plow. If we would have game birds and animals and fishes for our markets and tables and furs for wintergarments, there is no other alternative left us at this stage of our conquests, than to specially provide for their stay with us by foresting the waste places, by conserving our clear, cool waters under forest foliage, by propagative methods under the superintendence of the state.

PROMOTING PRECIPITATION.

The better to further comprehend practically the work done by the plant kingdom, the laws and conditions governing precipitation are here summarized:

Heat expands moisture; cold contracts it. Hot air can contain more moisture than cold air. The drier the air, the more rapid is the evaporation. The lower the temperature, the greater is the condensation of the air and the tightness of its particles, so that only a certain amount of moisture can enter.

The higher the temperature, evolving corresponding expansion, the greater is the capacity of a volume of air to entertain the aqueous vapor.

Other things being equal, evaporation is most vigorous the higher the temperature above that of the surface upon which it acts, and the least active when the two temperatures are the same.

In a dry air water is rapidly evaporated, even when the temperature is low.

If the atmosphere already contains much vapor, though the temperature may be high, the evaporation is conducted tardily.

Wind promotes evaporation proportional to its dryness and velocity.

Evaporation varies according to the extent of the surface exposed.

Vapors are absorbers and radiators of heat; being afloat in the air, driven hither and thither by the wind, they seem to moderate the extreme temperatures of the country over which they sweep. In this respect their virtue is

enhanced proportional to the quantity of vapor exhaled, and this proportional to the evaporating surfaces.

Vapors screen the soil from being too rapidly heated by day and too rapidly cooled by night.

Cooling the moist air may produce some form of precipitation. When a warm air is so saturated with moisture it can no longer hold the vapors as such, the result is rain.

Owing to shade and the moisture thereby economized, the air over an extensive and compact forest is generally cooler in summer than that over the open; when therefore, a moisture-laden wind passes over the forest, the tendency is to precipitation. It is surer if such wind is colder than the forest. If the cold or warm wind is drier than that of the forest, it absorbs the moisture of the forest and neutralizes the precipitation.

LAND ACCUMULATION OF VAPORS.

It is possible so to cover our soil with luxurious vegetation, including dense forestry on all the non-agricultural areas, as to have an atmosphere quite as humid as the ocean's, or at least fully adequate to our necessities. In the aggregate the evaporation from the plant kingdom is considerably greater than from the aqueous kingdom.

SCATTERING THE PRECIPITATION.

If the meteorological conditions produce precipitation, it may as naturally fall upon the open as upon the forest. This depends largely upon the direction and velocity of the wind. Though the forest may supply the heaviest load of vapors, yet the rain or snow may deposit itself upon some thirstiest plain, and the modest forest gets no credit from the professionals who say: "There are no evidences to show that forests cause an increase of rainfall!"

DEW.

Dew is moisture condensed from the air upon surfaces of cool bodies. It is proof that the air is more or less charged with vapors. If at night the sky is overcast, the radiant heat from the earth is intercepted by the clouds, preventing the cooling down process necessary to the formation of dew. It will form on clear, cloudless nights, when the air is sufficiently charged with vapors, more especially when a gentle wind brings fresh portions of atmosphere laden with moisture into contact with the colder bodies on the earth's surface.

It is needless to demonstrate the value of dew upon vegetation. In some countries, as in Southwestern Asia, agriculture is almost entirely dependent on dew. Every one has noticed how vegetation, wilting under the day's sun, is refreshed in the morning when impearled with dew. There is a great difference in the amount of woodland and the prairie dews; indeed the latter has scarcely any when most needed. "The dew is commonly

abundant near the border of a woodland, where the radiation may be less, yet the moisture is more, and the less amount of cooling may be sufficient for the precipitation of dew."

The night may be clear and cool all over the state, and dew may be deposited on open places of the woodlands, but none on the prairies. The strong wind that dissipated it in the latter case, is lulled to a gentle breeze under the forest protection, and there the people are specially blest. "When the dew is formed," says Prof. Kaemitz, (see Meteorology, Walker's translation, p. 107,) "it often disappears very quickly, if the wind rises, or the atmosphere is disturbed"—a circumstance most likely to occur on the open prairie.

FROST.

Frost is the ice of dew and mist, formed by the powerful radiation of heat from the substances receiving moisture, depressing the temperature below the freezing point. The chief of the United States weather department, asserts: "Anything that will seriously interfere with the rapid loss of heat after nightfall will tend to prevent the formation of frost. Moisture does this, and if the soil be well charged, it partakes greatly of the stable temperature condition of water, and cools but little, if any, below the temperature of the superincumbent air, and no frost will occur even though all other conditions of clearness, gentle winds and cool air obtain." A forest generally has the moisture requisite to neutralize the forming of frost. Its warmth often transforms the vapors tending to frost into fog mantles, saving the agricultural crops from freezing on the cleared spaces of the woodlands. The forest cover, having absorbed much of the day's heat, flings it back to the cooling ground, preventing the atmospheric temperature immediately around the growing plants from reaching the freezing point. If, then, our farmers would have refreshing dews, and hold them from changing into hoar frost, forestalling the loss of millions of dollars to their agricultural districts, let them surround their fields with dense clumps of trees.

HAIL STORMS—PREVENTION OF.

"Although the exact cause of hail storms is at present unknown," says Prof. Houston, in his *Outlines of Forestry*, p. 151, "yet the storms never occur unless marked differences of temperature exist between neighboring portions of the air. The removal of the forest from any considerable section of the country permits such differences of temperature to occur. In point of fact it has been noticed in parts of the world from which forests have been removed, that the number and severity of hail storms have undoubtedly increased.

Hail storms seem to move in zones, and are often attended with powerful electric discharges. They will turn aside or divide when they come to a large wooded area; they will sometimes change to rain over a woodland, and again to hail beyond. These phenomena "may be accounted for from the fact that the moist air that hangs over a woodland from the evaporation

of the leaves, becomes a conductor of electricity and thus lessens the effect of storms." By planting long and wide windbreaks in the storm zones to divide or weaken their force, we can, to a great extent, save our crops from destruction.

UTILITY OF SNOW.

It is estimated that the water which falls in snow in the northern states is about one-fifth of the precipitation, but the quantity of its crystals and therefore of its moisture is augmented by almost constant congelation of vapor impinging upon its surface during the winter season. Thus the snow becomes an accumulating reservoir of water. The snow on the treeless ground seldom lies in even depth, but is piled in drifts and blown into valleys, largely robbing the soil of its benefits, while in the woods and fields adjacent it serves as a furry garment, protecting the roots of slumbering plants and prolongs its slow melting long after that in the open, because of the tree cover and the excess of quantity accumulated in the latter part of winter. In the woods the snow presses lightly over the leafy litter, being filled with air, protecting against deep freezing and keeping the soil quite open for percolation as it melts, thus feeding our springs and wells. Aside from its protection, snow is an effective agent in preparing the soil for plants. It keeps the soil well loosened up and evidently produces needful chemical changes which our analysis is not yet able to measure; this we know, that it is about as good for the field or garden as a manure mulch. It unquestionably gathers up nutritive substances afloat in the air. The many colored infusoria living in its feathery flakes, die in the melting process of sun and heat, leaving skims of fertility on the soil. As on the farm openings of our woodlands, groups of trees on the prairie will cause the snow to fall on our fields where it is wanted.

SPONGY MOSSES.

Next to snow for water-holding are the mosses growing under forest cover on decayed wood and leaf mould. Prof. A. Kirkwood says: "Mosses of the species *hyphnum* which grow under the shade of conifers, can absorb up to five times their own weight of water, and peat mosses of the germs *sphagnum* up to seven times." Thick mantles of mosses are growing in our many cranberry bogs where our annual precipitation stores itself in the peaty strata, feeding our principal streams.

CRANBERRY CULTURE.

Various speculative plans are projecting to drain all these water conservatories for farms. Why destroy our cranberry facilities, which, under proper management, can be made to pay far more than any agricultural crop? This valuable berry can be raised there in great abundance if we will retain the white cedars and black spruces on these bogs, ample enough for shade, keep out fires, and control the water, not only for such culture,

but for bulkheads to our rivers and lakes. Speaking of the cranberry bogs of New Jersey—far less in magnitude than ours—John Gifford, editor of "The Forester," says: "A stream of considerable size flows through every important bog. It is often necessary to flood these bogs on short notice. The water, therefore, must be under perfect control. The water supply and the forest cover (especially the cedar swamps) upon which it depends for its regularity, are growing in importance to cranberry cultivators. Cedar swamps are natural reservoirs of water, producing a natural irrigation. They are usually located in the region of springs. The bottom of the swamp is usually covered with bog mosses and litter. These bog-mosses are noted for their ability to hold." It is very probable that with ample forestation with white cedars especially, and surface irrigation, many of our prairie sloughs can be utilized for cranberry raising.

INSECT ENEMIES OF OUR SHADE TREES.

"Their name is legion." If let alone, they will ruin every green thing. Having made slaughter houses of our birds, the "plagues of Egypt" are upon us. If your trees are infested with the Fall Web worm that eats the limbs where it spreads a web and extends it for new raids, apply the torch, careful not to further hurt the tree, and welcome the cuckoos that prey upon these implacable marauders. The Tent Caterpillars of the orchard as well as forest, that forage outside of their webs, common with us, must be treated in like manner.

The Green Striped Maple worm is not so numerous as the preceding, but it makes mischief with the soft maples. The farmer or sportsman who shoots the robins invites the ravages of this pest. It is not known to be in our state now to any extent, but we shall no doubt see this worm, creeping in upon us from other states just south of Minnesota.

Are there caterpillars on your walnuts, forming colonies on the under sides of the leaves? Pick such leaves off early as possible and burn them. Apply arsenical spray on the trees.

The leaves of our elms are frequently eaten by a beetle. Spray them with Paris green or London purple.

"No other family of beetles is so destructive to trees," says Prof. Luger, "as the one composed of bark beetles, and consequently they are feared whenever forests are taken care of or where new ones are planted" They burrow between the bark and wood, and will kill the limbs, if not the tree. To keep them in check, he recommends removing all wood from the forests "that has been cut a short time before the swarming period of such beetles. This is very important. A second remedy and one that has to be carried

out at the same time as the first one, is to prepare some trees as traps for the insects flying about to deposit their eggs. This will prevent them from depositing their eggs upon more valuable trees. Removal of freshly cut trees from the forests without preparing traps is worse than useless, as it is rather an invitation for the insects to increase upon good timber trees. Since we know that bark-beetles prefer recently injured trees, we have to prepare a number of such trees as traps. In the bark of such trap-trees the majority of the flying females will deposit their eggs. By removing the bark of such trap-trees after five or six weeks, and by burning the bark, an immense number of the immature bark-beetles will be destroyed." An elaborate and valuable treatise by Prof. Luger on this beetle, from which the above extract is taken, is found in the tenth edition of the Tree Planter's Manual.

Sometimes in early June the air is filled with May Beetles, visiting us at night, and preying upon our plants while we sleep. They hatch from the soil. But for skunks, gophers, moles, shrews and mice that relish the grubs, there would be but little hope for crops or trees. Set fires for the beetles to fly into, jar the trees where they light, gather them in sheets and burn them. Spray the foliage with Paris green. Let your domestic fowls scratch for them in the garden; they will eat them greedily. "Hogs will search industriously for them by rooting over the ground where they occur in abundance." Our white-winged gulls and other birds will often be seen in flocks, following the plow as it turns these grubs in sight. Killing such birds is unpardonable. The importance of destroying the grubs will be appreciated by the life history of the beetles as summed up by Prof. Lawrence Bruner, Entomologist of the University of Nebraska: "Shortly after bearing, the female beetles creep into the earth, especially wherever the soil is rough and loose and more or less covered by vegetation, and after depositing their eggs to the number of forty or fifty, die. These eggs hatch in from five to six weeks and produce grubs that feed upon the roots of various plants (our young forest trees with the rest.—Ed.) and grow slowly for upwards of two years, when they change to the pupa stage within cells in the ground which they construct for themselves. Within these cells the beetles remain during the remainder of the summer, fall and winter into the following spring, when they crawl to the surface and are ready to take an active part in the destruction of all kinds of tree foliage and to prepare for the propagation of future generations."

Our ornamental trees are meeting the fate of our forest trees—infested and seriously injured by wood borers of various sorts. Every tree has its parasites, that has to be treated according to its nature and habit. While in their moth stage, they can be largely diminished by building fires at night and spraying the plants with poisons. While in their worm stage, burrowing in the trees, they can be killed by injecting some alkaline element—bisulphide of carbon is effectual—into their burrows, afterwards closing up the openings. Smearing the bark with tar, washing the trunk with strong soap suds or white washing with lime, is a good preventive of the attack of

such moths or borers. The woodpeckers will also help us in the destruction of the borers. The man or boy who wantonly shoots one of these birds should be imprisoned.

Leaf beetles prey upon our cottonwoods and willows; dose them with poisonous spray. Serve the saw-flies, the gall-makers, the tree-hoppers, the plant lice with what they deserve.

My counsel is that whenever your trees are preyed upon by any kind of vermin, immediately consult Prof. Otto Lugger, our State Entomologist, and follow his instructions to the letter. The business in hand is to rid ourselves as much as possible of insect pests that are destroying our forestal and agricultural crops.

FRIENDLY INSECTS.

Professor Pantou, of the Ontario Ag'l College, says Public Opinion, gives a list of a few insects which are our friends: Syrphus fly, trachina fly, tiger beetles, lady-birds, reduvius, soldier bugs, lace-winged flies, wasps, cuckoo-flies, and ichneumons.

These insects are said to be of great importance in keeping the mischievous species under, the ichneumons being especially good at the business. They prey on certain grubs by depositing eggs on their living bodies. When these eggs hatch, the worms feed upon their host till the latter can stand the strain no longer and forthwith dies. About this time the ichneumons are ready to fly as perfect insects. It is no uncommon thing to find upon a tomato or tobacco plant one of the large green worms which infest these plants, with a dozen or so small whitish thorns sticking into its hide. These are the ichneumon eggs which eventually kill the worm. Lady-birds feed upon plant lice; the tiger beetle will eat almost anything in the insect line."

KEROSENE EMULSION.

One of the most useful of the insecticides, destructive to plant parasites, is the kerosene emulsion: Dissolve one-half pound of hard soap (best whale soap) in four pints of water by boiling. When the soap is all dissolved, remove from the fire and add eight pints of kerosene, and agitate the whole briskly until a permanent mixture is obtained. This is best done by using a force pump and pumping the mixture with force back into the vessel that contains it. The emulsion may be diluted to the desired strength and used at once, or may be used from when needed. The strength ordinarily used is prepared by diluting one part of the emulsion in ten or twelve parts of water, which makes the kerosene one-twentieth part of the whole.

NATURE'S MANUFACTORIES.

WATER-MAKING.

With an electric current, burn two volumes of hydrogen with one volume of oxygen; the result is water. What is this art but copying nature's synthesis? The decay of stones and other things by oxidation, or rusting, is a slow, burning method of water-making. By an analagous process a portion of our digested food is converted into water. We inhale air, or twenty one volumes of oxygen with seventy-nine volumes of nitrogen; by animal chemistry we appropriate what will make cell life, and exhale what is not wanted—the refuse of the compound, a watery mixture of carbonic acid gas and other gases. If this debased mixture is not some way separated and distilled, nothing animal can live in the sufficating air. The plants are equal to the emergency. With imperceptible force from the electric sun rays the plants, leaves especially, divorce the adulterated compounds, appropriating the carbon and freeing the oxygen for the animal kingdom. Thus one department of life lives upon what the other rejects. When hydrogen and oxygen are freed from other alliances, they unite in fixed proportions and form water.

AIR-MAKING.

By this electro-chemical art of nature the air is fitted for us to breathe. F. H. Hahn, in *Forest Leaves*, maintains "that the atmosphere is entirely a product of vegetation; that nature has no means of composing the air," except by the interchanges just described; "that it is not simply a chemical but a vital product; that its production, like its preservation, depends entirely on plants, and would be impossible without their agency. But as all plants united are not equal in bulk to the trees, it may be truly averred that any series of operations or accidents that should deprive the earth entirely of its forests, would leave the atmosphere without a source for its regeneration."

FOOD-MAKING.

When elements destructive to us in their crude states are vegetized they are food for us. What is it but a regenerating divinity in nature that, from filthy and disgusting offal, can and does transform it into garden vegetables and fruits? Prof. Remsen, speaking of nitrogen as an essential constituent of organic life, says: "The animals get their nitrogenous compounds from the plants, and the plants get theirs, partly at least, from the soil."

LIFE HISTORY OF RIVERS.

About seven thousand feet above the sea level is the average height of all the lands on the earth. Minnesota has nearly reached this minimum, for her average elevation is about 1275 feet. All heights are simultaneously undergoing erosion under forces in action competent to destroy the habitable portions of the globe in a single age of historic geology, were it not for the counter-balancing forces of the earth's internal heat, whose dynamics lift up the continents about as fast as the waters and winds level them down. Hence humanity need borrow no fear of losing its foothold. Prof. L. E. Hicks, geologist of Nebraska, aptly says: "Young rivers have steep gradients, swift currents, narrow valleys, sharp and high bluffs and few tributaries, while large blocks of the interfluvial surface are left undrained. Mature rivers have moderate fall and velocity, broad valleys, gentle slopes covered with vegetation, and numerous tributaries covering the whole surface of land with an intricate net work. Old rivers have a slight fall, sluggish current, and low banks."

According to this, what remains to us of the rivers and lakes of Minnesota have already reached their maturity and are on the race to perish and disappear. The ancient mountains, dotting what is now our Minnesota, have by ages of erosion dwindled to hill ranges, constituting a divide in the north part of the state, separating the waters of the north, the east and the south, whose general elevation above the sea is only about seventeen hundred feet.

FACTORS OF RIVER RECESSION.

The leveling down process of the centuries have prepared the way for the agricultural age in which we live. In entering upon our providential heritage, how few of us have bestowed a thought upon the sequences of our all-conquering energy and push. Every ax hewing down the trees, every plow subduing the sods, every plunge into the bowels of our hill-mines for iron and gold, necessary as it all may be to our civilization, has contributed to the recession of our water systems and thence modification of climate.

The two primal factors working this change are lumbering and farming. Ripping down the leafy roof of our native forests and thence drying and burning the leafy floor, have suddenly augmented the evaporation, exposed the river feeders to burning suns, lessening their general flow. The log-driving in the spring, when the ground is water-soaked and soft, has torn into the yielding banks, filled up the rivers with the debris, making them more shallow and wide, lessening velocity and augmenting evaporation.

Doubtless our farming operations have contributed more to the recession than our lumbering. Despite the extravagant cutting and needless fires,

young trees, springing up on the denuded districts, have got some foothold, retaining a measure of shade for our waters yet remaining.

LOWERING THE WATER LEVEL.

We must take into our calculation this law, that water seeks a general level; that sinking it in the forest by cutting, sinks it on the open prairie, and vice versa. No mathematical measurement is necessary to demonstrate that the general water level is lower down. Almost everywhere public attention is centered upon methods by which to find and lift up the stored waters beneath our tread to supply our thirsty plants.

Opening the soil opens capillary mouths; raising grains and vegetables thereon—our beautiful necessity—absorbs much of the moisture from the clouds. Fast, then, as our agriculture advances recede our rivers and lakes, for there is left precious little surplus to feed their sources. The question to solve is, how shall we balance our agriculture with our water systems so that neither shall suffer?

ROLLING LANDS.

The soil of our rolling prairies is generally rich and friable, but how often little rills, formed by showers and sudden melting of springsnows, plow down deep channels, wasting the best soil we have and greatly marring the symmetry of the farm. It is estimated that not less than ten per cent of our soil is carried away by rills, streams and floods.

HIGHLAND RAVINES.

Wherever a mountain or hill slope has been stripped of wood, it is ploughed by rills into ravines which collect the precipitation leaving barren the acclivities, and piling the chaotic debris in the valley below. The same mischief often occurs on the sandy descents of pine forests cleared for lumber. Lyell, the geologist, calls attention to places in Georgia and Alabama—and the same conditions are found in other states—"where the cutting down of the trees, which had prevented the rain from collecting into torrents and running off in sudden land floods, has given rise to ravines from seventy to eighty feet deep."

The deforested bluffs along sections of the Mississippi and its tributaries, are more or less rifted by the same agency. Down these shaggy descents sweeps the prairie soil in their vicinity, robbing such lands of their wanted fertility and leaving the higher places sterile as the desert.

HASTENING THE RUIN.

Inconsiderate farmers and herders burn over such localities, to secure green grass for their stock, thus destroying whatever mulch nature has been accumulating there, making the waste worse and worse year after year, till at length not a thread of vegetation can grow there. How thoughtlessly men hasten the ruin they seek to avert! If any grass grows there after the

burning, the stock, sheep especially, tear out the very roots, and even dig up what little surface soil remains, in which condition it is easily washed down by the first rain.

LAND-SLIDES.

In his admirable report upon forestry, 1893, Prof. A. Kirkwood, of the Department of Crown Lands, Canada, after giving a fearfully graphic description of land-slides arising from deforestation well says: "When the hill-sides are covered with trees, the snow which has accumulated during the winter months, disappears gradually under the influence of the milder temperature which accompanies the advancing spring; but when the trees have been removed, and the masses of snow are consequently exposed to the full force of the sun's rays, they melt rapidly and produce results upon the mountain sides similar to those which follow the occurrence of heavy storms of rain." Thus it is that a want of well-rooted forests on our highlands and cultivated prairies not only gives occasion for an alarming waste of soil, but of water absolutely needed to ensure good crops.

SOLVING THE PROBLEM OF FOREST REFUSE.

When a bill for the suppression of forest fires was first drawn up for legislative action in Minnesota, it was proposed to require every lumberman to safely dispose of the refuse from his tree cutting, but this was, on discussion, deemed impractical, and abandoned. The refuse therefore remains in the woods as before, menacing the lives and property of the residents, on account of their combustible condition in the dry season. It is questionable whether, with all the prudent caution which the forest commissioner may use to forestall forest fires, our woodlands are safe. Alarm will ever obtain so long as the refuse is not some way removed. It is obvious that lumbermen themselves, from business necessity for profit, will have to solve the problem, and thus become practical friends of forestry. It is already discovered and demonstrated on business lines that wood alcohol for chemical and other arts—not for beverages—is profitably manufactured from such refuse, more especially when it is beginning to decay. A superior grade of paper has been manufactured from the leaves before they have decayed. Now that wood fuel augments in price from year to year, showing that the raw material is rapidly lessening, it will soon be found that the chips and every available limb, down to an inch or even less, may be profitably gathered and shipped to the markets.

As our saw mill machinery becomes more and more multiform, requiring corresponding power or heat to run it, it will be, and in fact already is, found

that the saw dust and other refuse, where the best economy is used, are not sufficient supply for consumption, and limbs and tops for fuel are often hauled and burned. Such clearings are to be obtained in the near future, fast as the manufacturing mills are erected and operated in the lumber regions. Pretty soon not a slab will be wasted. Every piece of wood down to an inch block, or thinned for veneer purposes, or a little thread-spool, match, or a tooth-pick, will be utilized. Wood manufacturers, as in all other industries these days, have to calculate as to close margins, and know full well that there is practical economy in getting the most value possible into the least possible bulk; hence they are constructing mills at primary points, and working everything they can into finished products nearly, if not finally, ready for actual use; saving in cost of transportation, in cost of fuel, in cost arising from failing to float down the logs, when needed, to the city mills, where they have "monopolized the trade."

Thus it will prove by experimentation, that in order to keep the lumber business profitable, the whole method must be revolutionized; the most rigid economy instituted, allowing no waste of any description, and no refuse left for forest fires. Next will come up the great central question which lumbermen will have to meet from very necessity, what shall be done practically to save and grow trees for the perpetuity of the industry and the general benefits of the people at large?

HYGIENIC INFLUENCES OF FORESTS.

Prof. Cleveland Abbe, of the weather bureau, Washington, D. C., summarizing facts relative to malarial fevers, as given by Dr. H. M. Clark, of Amritsar, India, says in his excellent paper read at the World's Fair:

"The forests act to diminish malaria;

1. By shading the soil so that its coolness prevents the growth of malaria bacteria.

2. By diminishing the wind at the level of the soil and thus preventing the spread of bacteria.

3. By sifting the wind through their leaves the trees catch the germs or delay their progress and give them time to settle to the ground, thereby protecting localities to the leeward.

4. Facilitating the formation of fog at night-time, by which the germs are carried down to the ground and the air purified."

"When a current of bad air," says M. Becquerel, "laden with pestilential miasms penetrates a forest of a certain extent, it is wholly deprived of these properties. The effect of this is observed in the Pontine marshes, in which a belt of trees preserves all there is behind them, while the uncovered part is exposed to fevers. The trees, therefore, tame the infected air and deprive it of its miasms."

The observations of Ebermayer, a German authority, are, that "so far no pathogenic microbes have ever been found in forest soil; hence this soil may be called hygienically pure."

Biederman's *Ceneralblatt* (Germanic) affirms that "the innumerable leaves and branches of a forest in a manner filter the air, and retain the micro-organisms which float in the lower grounds; besides woods cut the cold and dry winds so dangerous to the organs of respiration, and render the temperature more uniform."

Dr. John H. Ranch, in his Report of Public Parks, with special reference to the city of Chicago, "gives a series of facts, clearly proving that the infection and diffusion of malaria or noxious emanations are arrested by trees, whose structure and canopy of foliage act in a three-fold capacity—first, as a barrier to break the flow, second, as an absorbent of these emanations, and third, as eliminators of oxygen."

Says Elizur Wright: "Ask your botanists, your chemists, all the people who have been studying the nature of things since Joseph Priestly discovered what air is more than a hundred years ago, and see if they will not tell you that animals could never have lived and cannot live long on this earth without forestry to purify the air. You may ask the historians, too, if great nations have not decayed and become puny and degraded because they made broad and fertile valleys bare of forests."

Another serious fact should be considered, that when rivers sink lower and lower in a dry hot season—traceable to deforestation at the water-sheds—they float to the towns and cities through which they flow, the garbage of the country that is full of wrigglers, microbes and poisons that also contaminate our wells. Innumerable sicknesses and deaths follow. The antidote for these sorrows is forestry. Is it not, then, the duty of the state to enforce its development proportional to the hygienic necessities of the people?

ESTABLISHED FOREST RESERVES.

Of the timber reservations, we now have the following: In Colorado, that of the White River Plateau, of more than a million acres; the Pike's Peak, of nearly two hundred thousand acres; the Plum Creek, of about the same dimensions; the South Platte, of more than half a million acres; and of the Baltimore Mesa, of over eight hundred thousand acres. In Oregon, that of Bull Run, of Cascade Range, of about four million and a half acres; and of Ashland, embracing nearly nineteen thousand acres. In Wyoming, the addition to the Yellowstone National Park, of nearly a million and a quarter acres. In California, the San Gabriel, of over half a million acres; that of the Sierra, of over four million acres; of the San Bernardino, of over seven hundred thousand acres; and that of the Trabuco Canyon, of about fifty thousand

acres. In Washington, that of the Pacific, of nearly a million acres. In Arizona, that of the Grand Canyon of the Colorado, of over one million, eight hundred thousand acres. In Alaska, that of the Afognak Forest, and Fish Culture Reservation, embracing the whole island and circumjacent rocks and waters. These reservations embrace in all over seventeen million acres, besides 3,274,240 acres comprising the four national parks. These areas chiefly include watershed regions, and protection of the headwaters of streams—a measure of high importance, which Minnesota should consider.

PUBLIC PARKS.

But for public parks the residents of our large cities would verily suffocate. The authorities are generally alive to their hygienic necessity. But why is the park system so neglected in the country places? Plenty of room is there at slight cost. We of the country may not be able to have the social privileges of the city, but we can, if we will, compensate for such lack by even excelling the city in healthfulness and beauty.

Our last legislature did itself credit by locating one, conjointly with Wisconsin, at Taylor Falls. Itaska park is another, donated by the national government, located at the headwaters of the Mississippi. It is neglected. If enlarged and properly cared for, it would be one of the most health-invigorating and water-conserving parks in the northwest.

RESERVES AND PARKS.

At the annual meeting of the American Forestry Association, held last Sept., at Springfield, Mass., a resolution was passed, congratulating Minnesota in having a forest fire warden system to protect forest property and life, and by another, applicable to all the country: "That the policy of establishing forest reservations and parks is to be encouraged, and for this purpose it is recommended that timber lands offered for sale for non-payment of taxes be acquired by the State and held to form the nucleus of state forest reservations."

What better use could be made of our abandoned and worthless lands forfeited by tax sales, than to have them permanently held by the state and devoted to the purposes of the production of trees, for which they are admirably adapted?

A new way of seasoning lumber is being developed, and bids fair to become an important industry. By the new process the sap is sweated out of the boards by being placed in a green state in steam chambers for twelve days, then it is put into the drying chamber for two or three days, and by a chemical application the wood is stained throughout a rich walnut color.

TREE BOUNTIES.

The tree bounty act of 1873, requiring a tax levy of one-tenth of a mill upon the taxable property of the state was repealed by our last legislature, but the amended clause of said act, limiting the amount to \$20,000 annually, was retained, payable from the general revenue. The aggregate of tree planting under the operation of the act, dating from its inception, is estimated at 100,000 acres of substantial trees.

To be entitled to bounty, applicants must show that trees were originally planted not more than eight feet apart each way, and were kept in a thrifty, growing condition, and were maintained at such distances by replanting each year all that may have died during the year. Applications should be made July 1 to 15 to state auditor for blanks. The assessor records your answers to the questions on the blank. In all cases two freeholders, residents of your town, must attest your statement, together with the assessor's acknowledgment of its validity. It must then go to the county auditor for attestation, and when it reaches the state auditor, and all is right, you get your bounty at \$2.50 per acre.

As not half of the counties draw bounties, and as the saving of our native trees, partially grown to timber conditions, are considered valuable as our planted ones—more so, in fact—it has been suggested by lumbermen and others, that the bounty act be so amended, that whoever shall plant or save a special class of trees, say pines, oaks, ashes, maples, etc., on so many acres, averaging not less than eight feet apart and shall preserve them from the ravages of fires and stock, for a term, say of ten years, shall be entitled to a bounty from the state of \$2.00 per acre. This certainly is just and equal, and evidently would contribute to the rescue of much of our native forests from the prevailing vandalism and abandonment.

The objection often raised, that the state should not pay a man for improving his own premises, would be logical, were the improvement limited to the man's private benefit. Raising trees bears no analogy to raising a crop of potatoes or corn. They are not annuals; they live after we are gone. They are bequests to our successors. They are factors of climate, of general agriculture, of the people's healthfulness. As rivers and lakes are public benefactions, so are forests. The framers of the bounty act viewed the matter in this light, and our legislatures have ever since builded upon this principle. Evidently the bounty law is weak in that it does not recognize the inherent right of the state to supervise the trees it has paid for. While such belong with the farms where they are growing, and are as inalienable as the soil, in justice to itself, the state should step in and declare that they shall not be neglected nor removed; that the cutting shall be only by government al permit to the proprietor of the farm, to the end that such forests shall be preserved for climatic uses and rural beauty.

ARBOR DAY HISTORY.

About thirty years ago this editorial appeared in a New England paper: "Let every state have a general holiday to be devoted to tree planting. Close the schools and let the children turn out and take part in the proceedings." Other papers copied; the suggestion was discussed and approved. It germinated in the public mind. In 1872 Hon J. Sterling Morton, the recognized author of Arbor Day, now secretary of the United States Department of Agriculture, then Governor of Nebraska, introduced a resolution at a meeting of the State Board of Agriculture, which was unanimously adopted, setting apart the 10th day of April as a day consecrated to tree planting, and offering a special premium for the proper planting of the largest number of trees. It is stated that on that day over a million trees were planted in Nebraska. In 1874 his successor, Gov. Robert W. Furnas, issued the first Arbor Day Proclamation which was generally observed, and the next year the legislature of that state made it a legal holiday in Nebraska.

Arbor Day in Minnesota was inaugurated by the State Forestry Association the year of its organization, May 1, 1876, under the leadership of its secretary, Leonard B. Hodges. Great interest was evoked. Over a million trees were planted for prizes alone. Hon. L. F. Hubbard, in 1885, was the first governor of our state who proclaimed Arbor Day under the school regime, followed in the succeeding administrations by Governors McGill, Merriam, Nelson and Clough, co-operated with by Prof. Keihle, superintendent of public instruction; and equally earnest by his successor, Prof. W. W. Pendergast, and county superintendents and principals of schools generally throughout the state. Since these initial steps Arbor Day is annually observed in nearly all the states and territories, Canada, Europe and Australia, New Zealand, South Africa, and will soon be world-wide.

OBJECT OF ARBOR DAY.

Some professional forester pertinently asks: "What is the object of Arbor day? To plant shade trees and have a good time? Oh, no! Although the setting of a tree is useful and pleasurable, although the festivities attending it are pleasurable and useful in impressing the mind with the memory of the occasion, the deeper object of Arbor day is to so imbue the coming generations with a love of tree growth and tree planting that out of a nation of woodchoppers, there may arise a nation of tree planters and tree foresters."

"What is needed is to embody the beautiful sentiment of the Day in practical form for discipline of foresight, in stability of purposes and character. Enthusiasm should be aroused, but too often it ends in gush and display. Generally the after care is not provided for. "What is everybody's business is nobody's business." Let us not vie with each other in planting many trees but in planting what will be rightly managed to live, even after we are gone to our reward. Let the instructive lessons be plans for improvement. The

State Superintendent of Irrigation and Forestry of North Dakota sensibly urges that, in addition to the regular exercises, "there should be thought bestowed upon and action taken to secure, if possible, larger grounds for the school houses the proper fencing of the premises and a systematic plan for the adornment of the same, involving the planting and cultivation of trees, shrubs, vines and flowers; pleasant walks, with a well of pure water, together with miniature lakes etc., to the end that ultimately the sacred spot, dear to every lad and maiden, may be converted into the semblance of an attractive park, thus producing those environments and influences that conduce to the harmonious development of the highest and noblest attributes of mind and spirit."

ARBOR DAY IN THE WOODLANDS.

Why not celebrate the saving as well as the planting of trees? The forest is already in growth; are they not equally worthy of our attention? Are we not doing excellent work if each of us saves a tree each year? and should we not accommodate ourselves a little more to the trees which nature has planted for us? Yes, plant them on the farms, along the highways, in the cemeteries and parks and lawns, and around the school-houses and churches dedicated to the deities of Use and Beauty. But we must do something to eradicate the vandal disposition and habit of indifferent treatment to our native trees, of cutting down wild cherry, plum, butternut and other forest trees simply for their fruit, caring nothing for their future needs. The observance of the Day by the woodland schools with speech and song and historic lessons associated with venerable trees, with the replanting in the cities and villages and at the rural homes of the firs and maples and the acorns of the oaks, would surely influence the youth to be the guards of our forests and the patriots of our country.

APPROPRIATE PLANS.

It would be a good idea to have a registry of the trees planted, also a draft of them preserved each year in the archives of the school library. And what has been accomplished should be reported to the secretary of the State Forestry Association to be incorporated in his annual report.

INDOOR EXERCISES.

Prof. N. H. Egleston, of the Forestry Division of Agriculture at Washington, D. C., who has competently given the observance of Arbor Day special attention, suggests a program like this: The reading of the laws of the state relating to Arbor Day; reading of letters from forestry friends living abroad; brief addresses and essays on the subject of forestry; forestal quotations from eminent authors, both prose and poetic; responsive recitations; songs of the trees and flowers and birds; voting for the tree or flower that shall be the emblem of the school for the year; "to facilitate the voting, a blackboard facing the pupils during the exercises with a few drawings of trees and flowers, each with a characteristic attribute printed beneath it. The voting may be expeditiously performed by pointing to the drawings."

FORESTRY IN OUR PUBLIC SCHOOLS.

There is so much to do in our educational enterprises it may seem a mental tyranny to even suggest another study. If, however, forestry can be made a restful exercise, lighting up the technical task, checking physical vigor for mental application, it should command our candid consideration.

Can you think of a primary science that does not include the plant kingdom? The superficies, solidities, lines, curves, forms and heights of trees teach us mathematics. The functions of vegetable tissue, of barks, roots and leaves teach us chromatics. Their moisture-breathing organs and temperamental influences teach us meteorology. Their kindred relations to ancient plants, as discovered in fossil remains, teach us paleontology. Their crystals, found in rocks and coals, teach us geology. The great forests, where our progenitors lived, battled and died, teach us history. The oaks of the Druids, the banians of Ceylon, the palms of Palestine teach us religion in "God's first temples." So in improvements, in landscape gardening, in good roads, in lawn ornamentation, in farm culture, trees are central figures. No scholarship is complete without a knowledge of their uses. How, then, can forestry be consistently left out of our educational curriculum?

USES OF FORESTS.

Of the practical uses of forests in the economy of nature and art, this is a summary:

They furnish fuel and lumber for our homes, and for improvements in industry and travel.

By their life and decay they are soil-makers.

They are the breeding-places of our birds and game animals, and in their cleaner and cooler waters we are supplied with the best qualities of fish.

By their roots and leaves they extract nitrogen from the ground and atmosphere, necessary to agricultural growth.

By their roots they penetrate into the wet chambers below the soil, sip up the water, serving as capillaries of moisture for the plants.

By their leaves, under the electric action of the sun, they separate the oxygen from the carbonic acid gas, appropriating the excess of carbon for the growth of vegetation, giving the now revitalized oxygen to the animal kingdom, thus balancing the life departments of creation, each living upon what the other rejects.

By their shade under foliage in the air and dead leaves on the ground, they economize the life-evolving processes of evaporation and transpiration.

By their chemical action, together with shade, they cool the air in summer, and, from their stored heat in woody tissue, warm the air in winter.

By their tree trunks and roots and entanglement of sticks and leaves, they dam back the spring waters, largely preventing the damages of floods.

By these checks under shade they hold in tact the lake and river auricles and ventricles of our country, saving water for the farm and city.

By their tall, living walls, they intercept the wind and hail, mitigate the extremes of heat and cold, sift and refine the air we breathe, making for us a healthy climate to live in.

THE TREE SPOILER,

As forestry is a factor correlated with our practical sciences and arts, concerned in the very issues of life, we cannot, if we would, separate it from our education. Forestry in our schools—right here centers our hope. It is useless to expect the tree spoiler will espouse this cause. He is too busy using up the forests to give it any attention. What cares he about others' equal claim to the bounties of Providence? What thought will he bestow upon the injury he is doing to the climate, ripping up even the water systems of this country, provoking the desert? If we rely on him to promote forestry, we are guilty of casting pearls before swine that turn and rend us.

LEGISLATIVE ACTION.

Nor is it wise to wait the action of legislature. It comes not unless the people demand it. Only when we have popularized forestry, by judicious agitation, can we have a governmental management of it, republican in structure and therefore broader than the European. To this end we appeal to our educational professors for co-operation. But the Minnesota legislature, conservative as it is and should be, has always committed itself initially to the great work, and is in the van of state forestry. The fact that it gives a liberal bounty for tree planting on the open prairie, and support for the State Forestry Association, and forestry instruction in the horticultural department of our Agricultural School at St. Anthony Park, and has at last instituted a fire warden system to prevent and smother forest fires, and the fact that the governor annually proclaims the observance of Arbor Day, is proof positive that forestry is coming to the front educationally and practically, and in the near future will loom up in grand proportions as the most useful feature of the state.

FIXING THE ATTENTION.

If it be asked how can forestry be taught in our schools, and not infringe upon other studies, as required by law,* I answer, undertake it for the present, mainly without text books in the hands of the pupils. As is well known, the prerequisite to success in teaching is ability to fix the attention. This is secured when the teacher feels an interest in the subject, and thinks with the pupils. If the teacher takes no stock in trees, or concludes other subjects are more important in scholarship, of course it is useless to undertake it. It may be safe to say that a teacher who does not love the trees is not a lover of children, and in that case will not succeed in the profession.

Have we any teachers in Minnesota, so inattentive and indifferent to forestry, they cannot distinguish one tree from another, and yet may have lived where a variety of them grow?

AN UNSCHOLARLY YET PRACTICAL FORESTER.

During one of my jaunts into the woodlands of our state, I accosted a young man going from the village school to his home, inquiring, "what tree is that?" pointing to a bur oak by the road side, just to call him out. He looked at it, probably more attentively than he ever did before, answering, "I do not know." He had passed that tree six or eight times a day, and yet did not know even its name. From his age and manner I calculated he was a pupil in the high school department. The natural inference I drew was, that the youngster's attention had not been directed educationally to trees, though literally surrounded by them. and that too, in a lumber county, and that the responsibility rested upon the teacher. In that village I had business with a farmer whose conversation proved that in his young days he had but little schooling, but for all that was well informed in practical matters. He had gathered stones of various constituency and color, not knowing their genera or species, piled them up tastily in his rustic lawn, and trailed some wild vines over them. He had a little cabinet of mineral and wood specimens in his humble parlor, not one of which was labelled. He had evergreens and fruit trees all around and within his premises. In his back yard and shop were heaps of various species of wood which he had gleaned from the native forests. Going with him among the timber trees, I learned important facts, not found in the books, how to determine the condition of the soil from the external appearance of the trees, how from the limbs or bark, whether they were shaky or hollow-hearted, how to cut them to best advantage, how to load them, how to saw them economically. I met this man at the World's Fair, and noticed how much more observing he was

*The attention of educators and all concerned is respectfully called to the "Sylvaton System," organized in North Dakota, under the leadership of Hon. W. W. Barrett, Superintendent of Forestry and Irrigation, the objects of which are to pave the way on the lines herein defined. The constitution of this useful society is embodied in the 10th edition of the Tree Planter's Manual, an elaborate work on practical forestry, a copy of which can be procured of the writer.

than others finer dressed and disposed to call him "a crank from the backwoods of Minnesota." Attentive observation and diligent inquiry had evoked in the mind of that farmer, though unskilled in technics, a genuine scholarship, far ahead of those who pride themselves in book knowledge without its practical application. Do not understand me as discounting the value of the text book. It aids in fixing the attention and in finding new and ever engaging sciences and arts. In this analytic investigation nothing so enchants the mind as the plant kingdom. The technical with the practical—this is the true line of scholarship. When skilled in adaptable tact, the teacher can instruct incidentally, and thus throw new light upon a subject that may at first seem foreign to forestry.

DUPLICATING INSTRUCTION.

Suppose, for instance, a recitation in physiology is called. As is the common practice of all adept teachers, things in lesson are compared with analogous things, thus duplicating instruction for a more rapid and observational progress. In drawing out thought upon the bony framework of the human body, mentioning the constituencies, forms and joints, by way of illustration, structures in a tree can be cited; its siliceous element, its waxy hardness, as in a Norway pine, its tenacious fibre strong as the human skeleton.

"For a basis of support," says the teacher, "we have limbs that project downward—legs, feet, toes; and limbs, quite as handy, swinging at will in all directions—arms, hands, fingers. So a tree has root limbs for feet and toes, but not walking about as we bipeds do; and air-limbs and twigs, reaching where it wants to. The ancient Hebrews, you know, aptly called man a tree, and a good man 'the tree of life' in the garden of intelligence." Here follow questions and answers about the various visceral organs and their functions, and when those of the stomach are reviewed, the teacher adds: "I want to thank the girl who brought us this white lily this morning, and the lad for his bunch of apple blossoms with some leaves attached. They will elucidate our subject. As revealed by the microscope, this lily leaf contains about 60,000 breathing pores to the square inch of the epidermis of its lower face, and about one-twentieth as many on its upper face. On the lower face of this apple leaf are about 100,000 of those little mouths or stomata. You see leaves with their flowers are lungs and stomachs combined. Under the microscope our stomachs appear honey-combed, having little mouth pits, so to speak, not greater each than one three hundred and fiftieth of an inch in diameter. And this is no more wonderful than that color has something to do with floral fertilization, human digestion, respiration and even thought. What is the color of leaves? Green, you all say. Right, and I shall have to use so hard a word you will remember it—*chlorophyll*, which means *leaf green*. It consists of soft grains or wax-like cells, and its function is to convert and assimilate crude sap into vegetable tissue. The color of the mucous membrane of our stomachs is a pale pink, or straw color, very much like that of the under face of some leaves, and like

chlorophyll is really a celled substance, chemically aiding in digestion. Yesterday you told us our brains have convolutions of gray matter, essential to the evolution of thought.

"Did you ever think that the plants, trees serving as the greater functions, prepare all the food which we and the rest of the animal creation live on? Such is the fact. They extract needful gases from the minerals and soils, from the atmosphere and sunbeams, refine, vitalize and reconstruct them into their own vegetable substances whereby animal life is sustained. Sometime I will further explain this, that you may better understand how essential it is that we keep the plant kingdom in tact, trees especially, on a scale necessary to support the animal kingdom in mutual balance. Meanwhile I want you to study the beautiful correspondences between the breathing apparatus of our lungs and that of the leaves, and the flowers particularly, whereby vegetable species are propagated; between the blood-pumping forces of our hearts and arteries and those of the plants pumping and forcing sap from the roots to the leaves and flowers, where it undergoes a chemical change like that of the blood in our lungs, and thence returns building up new life-cells in the body. Will you all try and glean some information about these things?" All hands go up. "Well, report at our next review."

One of the best methods by which to develop the latent talent of school-children, is to set their imagination at work personating things in story. Nothing can so well fix the attention respecting their uses, also awakening consecutive thoughtfulness. For illustration, I cannot do better than to quote an article from the Arbor Day Manual of the Department of Public Instruction, North Dakota, happily entitled

AN ARBOR DAY STORY.

One morning early in May a family of rain-drops went sailing across the sky in a cloud. Pretty soon one of them rolled out, and down he splashed, right on the hard, brown earth. It didn't hurt him a bit, though, so some of his brothers and sisters thought they'd roll out too. And sure enough they did, tumbling over each other in a great hurry to see who would get down first. Down in the dark earth there was a little crocus flower fast asleep in her dainty pale green bed. When the first rain drop fell she woke up. She thought it was some one rapping, so she called out, "come in." No one but a rain drop could have heard her sweet little voice but he did, so he ran right in. The other rain drops weren't so polite as their brother and they ran right in too, without waiting to rap. When little Miss Crocus found out who her visitors were she was very much surprised. She sat right up in bed and threw her pale green-quilts aside and looked at them. But they kept coming faster and faster and Crocus thought; "Well dear me, you rude rain drops, you have spoiled my sleep anyway, so I may as well get up." She didn't say this to the rain drops though, for she was a very polite little crocus. All she did was to put on her green dress, tie on

her lavender colored bonnet and walked right out doors. When she got outside and saw the blue sky and heard her old friend, Robin Redbreast, sing his spring song, she was glad the rain drops woke her up. She was gladder yet when she saw what was going on around her. A tall fine-looking tree was standing near her. Boys and girls with hands joined were circling around him singing a gay song. Little Miss Crocus had never seen anything like that before, and she didn't know what it meant. After a while she whispered to a slim well dressed-fellow in green who stood near her, "What does that mean, Mr. Grass?" Now Mr. Grass had been out in the world longer than Miss Crocus, and he knew all about it. He made a very low bow before he spoke, then he said: "That very tall gentleman is Mr. Cottonwood Tree. He came from the woods over there to live among us in the school-yard." Mr. Grass had just started to tell Miss Crocus all about Arbor Day, when who should come puffing up but Mr. South Wind. "Well, well, he said, how do you do, Miss Crocus? I haven't seen you all winter." And he shook hands with her so hard that he nearly shook her new bonnet off. "Nice looking young man is Mr. Cottonwood Tree; I used to know him when he was a little fellow and lived down in the woods, but I must be off. I promised to swing Mrs. Robin Redbreast in a wild grape vine today. Good bye!" said Mr. South Wind, and away he ran over the prairie toward the woods whistling as he went.— Grace Brown Putnam, Class of '95, State Normal, Mayville, N. D.

SOUL OF SCIENCE AND ART.

In ways like these, rudimentally considered, the teacher can evoke not only special interest in the study required, but an analytic habit of observation, forestry serving as the open door to the temple of knowledge, where is revealed unity of life in diversity of form. To the teacher and pupil forestry becomes the very soul of science and art, transmuting itself through all the animate and inanimate creation. It plays naturally into chemical analysis and synthesis, into mensuration, into natural history, into political economy, into antiquary, into physical geography about configurations of country, leading inquiry as to its lakes and rivers and their sources in precipitation and springs, and thence forests, whence all chief blessings come; into ethics and drawing and poetry and song.

FORESTRY CHAIR IN OUR UNIVERSITY.

Yet strange to tell, forestry has no place in our educational curriculum. It would seem that at least we should have a forestry chair in our university, but it is, legally speaking, ignored there, as well as in all the grades that support it. True, botany is ably taught there, but this cannot, as now adjusted, cover all the essential needs of the situation. The nearest kin to it is our Experiment Station, a branch of the university, but the benefits of forestry are circumscribed to the farmer boys who, to their credit, heartily appreciate its utility on the farm. It is not enough to know what plants are indigenous or adaptable to the state, what their families and species,

and how to analyze them. Mere book knowledge, comprising only the technics of forestry, though very important as data, is at best but an intellectual negation. The extension of such knowledge into the practical is the great need of the times. It is the prerogative of Minnesota to lead the union of states in this direction. In our university real, where we look for finish of scholarship, the following problems should be deliberately considered, imparting practical information to the higher grades of our common schools, influencing their action co-operatively, and that of the press, thence reaching all our people:

What are the best ways by which to produce profitable forest crops without destroying the forests?

What can be done to harmonize the lumber interests with forestry, so as to perpetuate and enhance them?

What methods can we use in connection with forestry, to conserve our water systems for agricultural and commercial advantage?

What areas of woodlands should be appropriated to forest reserves?

What further encouragement should be given to tree planting in different parts of the state, by way of windbreaks and other forest groups?

What methods, inter-state and inter-national, can be projected by which to break and soften the cold and hot winds, so destructive to our crops as they sweep over the Great Plains?

SOME RULES FOR TREE CULTURE.

This fact has budded itself in the public mind, that beauty in art and truth in symbol are essentials in education. Conceive of a school house attractive in architecture, convenient inside, well lighted and ventilated to ensure good health, having the needful apparatus, including a library and cabinet of mineral and wood specimens. Is it yet complete? What is a palace home without a beautiful environment? Equally important for the public home, the school house, are pleasant walks, trees, flowers, vines, singing birds.

SCHOOLHOUSE LOT.

For a first-class institution, the lot should not be less than an acre, but for the present, until community has broadened enough, we shall have to accept what is generally allowed, half an acre; and this even is a splendid advance from what we had when boys and girls, trying to educate ourselves in a seven-by-nine coup and a playground in the highway.

SOIL PREPARATION.

First prepare the soil. Our wild grasses bind like a wooden floor. They must not be allowed over the roots of the plants. Our tame grasses, clovers especially, keep the soil more friable and are far more pretty. But no grasses or weeds of any description should be tolerated directly around the young trees; not until they are large and strong rooted.

HIDING DEFORMITIES.

A few elms and evergreens and vines should be planted in the backyard, hiding the deformities of the buildings there, and sipping up all malarious atmospheres, and now and then one such tree quite central in the lawn but away from the house. Too much shade is unhealthy. The holes for such trees should be as large as a cart-wheel and at least half as deep, and cultivated earth used for the trees to start in.

PRIOR CULTURE.

Plow deep around the oblong square, say ten or more feet wide, for the main portion of the trees. Do not plant them there the first year, but raise something on this strip. Nothing injures a soil so much as keeping it barren. Plow again as soon as the corn or potatoes are gathered, and harrow fine. Plow again before the ground freezes up, and harrow. All this preparation, if you must plant the trees next spring, but another year of such culture would be preferable.

YOUNG TREES PREFERABLE.

Select indigenous and nursery grown trees—ashes, elms, box elders, white spruces, white pines, soft maples, etc. It is not a gain of time to plant bare poles with roots on them, nor will such ever have well balanced and pretty foliage. If you plant trees, say, three to four and five feet high, handsomely pruned a little to counter-part the roots whose fibers you have carefully preserved, they will, rightly managed, soon overtake the larger ones, and be ten times more valuable in "The sweet by and by."

METHOD OF PLANTING.

Do not expose the roots a single minute. Spread them out natural. Plant from one to three inches deeper than they grew. Put the fine dirt close to the roots. If the ground needs it, moisten with sunned water. Cast on a layer of top dirt. Press it down. Another layer pressed, and so on, leaving an inch of loose dirt on the surface, the ground tipping toward the trunk to catch the rain. If you have put that tree in solid as it grew, so you cannot pull it up, it is "right side up with care." It is important to plant them thick for mutual protection, and thin out in due time, saving the fittest.

DUST BLANKET, BEST MULCH.

Experience has taught us that a mulch of finely pulverized dirt, often stirred superficially, is safer for our trees than six inches of straw or grass mulch left untouched the summer through. By capillation saline particles in the ground, known as alkali, are brought up to the surface, hardening in the sun's heat. The crust during the drouth season will extend under ordinary mulch. Only by frequent stirring of the soil can it be broken up. This lets in the air absolutely necessary for root-breathing and digestion. It would be just as consistent to exclude air from the leaves as from the roots, and expect that in either case the tree will live. If the cultivation is deep, especially in the dry and heated summer, we open dangerous ducts

in the soil, expose it too much, advance too rapid evaporation, and moisture-reserve in the sub-soil is soon lost to us, and the tree dies. The mulch we usually put around our trees more or less intercepts the rain from soaking down to the roots; the dry air, sponge-like, sips it out, and the shower has done less good than if that sort of mulch were out of the way. On the contrary the "dust blanket" allows the water to filtrate into the soil, refreshing the tree. If you use the straw manure, or grass mulch, throw it off when the leaves show signs of wilting and dying; spade up the soil thin; moisten the ground thoroughly with sunned water, and throw back said mulch. If, to save the trees, you have to do this in August or early September, it starts the sap flowing and cell building again, not allowing them time to ripen up for the winter ordeal. The dust blanket is not attended with so much peril. By superficial stirring with short fine teeth of the cultivator or hoe until the middle of July when cell-building is generally then suspended, the trees are kept in health, and the cells gradually ripen.

DUTY OF THE SCHOOL AUTHORITIES.

This ornamentation of the school yard should be considered by the district trustees just as much public property to care for, as the books and apparatus within doors, and equally necessary in the educational work. A duty of rare interest also devolves upon the County Superintendent of Schools, to suggest improvements each Arbor Day, and urge all the teachers to have the trees and other plants in special charge, and co-operate with the trustees and community to see that nothing of the kind is injured or neglected.

BUNGLING PRUNING.

Many of our ornamental trees are seriously injured by bungling pruning. An idea prevails that nature does not know how to balance them. We can sometimes assist, but generally our interference is a botch. If we prune at all, do it for healthful conditions and beauty of form. Avoid anything set or stiffly artificial. If the branches are sawed off an inch or more from the trunk, as is frequently done, it is impossible for nature to heal the wounds. Always prune close to the bark. The roots of a tree are proportioned to the branches. If then you saw off large live branches which nature cannot heal over, the roots at once begin to die, and the rotting roots convey rottenness to the trunk. The bungling pruner virtually stabs the tree to the heart, for the stumps he leaves on soon rot, and convey the rotting tendency downward as the rotting roots do upward. A severely pruned, or a badly pruned tree soon becomes hollow, and seldom lasts many years. Prune when the trees are young, and "be harmless as a dove."

FENCE SCHOOLHOUSE LOTS.

All school house lots should have neat and durable fences around them to keep out the cattle and other rummaging animals. Do not allow any of

the trees to be used for hitching posts. Gnawing off the bark by horses, rabbits or mice, shortens a tree's life considerably. Only half the necessary amount of moisture and food that the tree needs, can be drawn up from the roots, if the bark is half removed around the tree. In a dry time such a tree may die at once or gradually dwindle away. It may be saved, when the wound is fresh, by covering it with a waxed cloth. An excellent way is to spread some fresh cow manure on a cloth and tie over rather loosely, so as to allow circulation. But the most sensible management is to forestall all wounds. To guard against the teeth of rabbits and mice, tie any kind of paper—except tarred—around the trunks just before winter sets in.

On some of our older school grounds are large trees, having cavities in the trunks, which, if not properly treated, will soon destroy them. Cut the edges of the cavity smooth and even; remove all decomposed matter; plug the mouth with a piece of seasoned oak, securely driven in; cover the whole with coal tar, and nail on a piece of zinc or some other metal, in such a way the growth of the new wood will in time completely cover it. Remember, planting trees implies caring for them.

We cannot afford to delay the execution of this high responsibility. If not successful in the first experiment, try again, profiting by the lesson taught. If we would content the people, inspire love of home and country, if we would make the School what it ought to be—supreme in excellence—then plant and nurture trees whose whispering tongues will be idyls of moral beauty builded in character.



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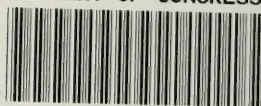
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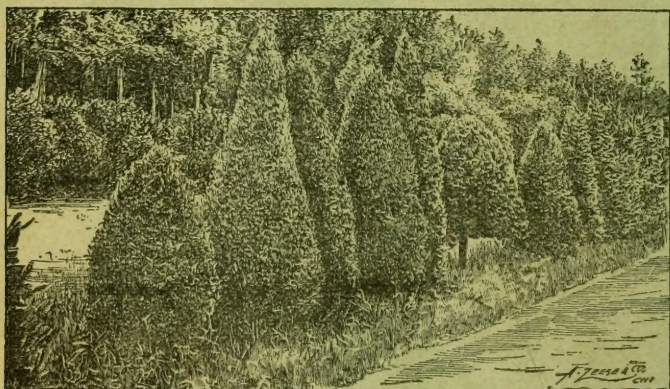
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